HSS
Office of Health, Safety and Security

Office of Health, Safety and Security Visiting Speakers Program

Panel Discussion on the Status and Future of the U.S. Industrial Base

January 12, 2009
U.S. Department of Energy
Washington, DC

Office of Health, Safety and Security

The Office of Health, Safety and Security (HSS) is the Department of Energy's (DOE) corporate organization responsible for health, safety, environment, and security; providing corporate leadership and strategic vision to coordinate and integrate these vital programs. HSS is responsible for policy development and technical assistance; corporate analysis; corporate safety and security programs; education and training; complex-wide independent oversight; and enforcement. The Chief Health, Safety and Security Officer advises the Secretary and the Deputy Secretary on all matters related to health, safety and security across the complex.

Through its research on sustainability and industry's successful use of its concept, HSS has a clear idea of the types of organizations with which it would be beneficial to collaborate on sustainability. Such outreach efforts provide a cooperative advantage of sustaining an organization's efficiency and vitality by bringing together creative thought and diverse viewpoints toward common goals while demonstrating leadership's commitment to listening to and reflecting the concerns and issues of its shareholders and stakeholders.

As the first phase of its outreach efforts, HSS created a Focus Group forum. The HSS Focus Group forum integrates senior HSS managers from across the organization to discuss and address topics and issues of interest to DOE managers and stakeholders. The objective of the Focus Group is to establish a means for responding to questions and concerns regarding HSS initiatives and activities for improving, the health, safety, and environmental and security performance within the Department and to maintain an ongoing dialogue with involved parties supportive of these efforts. HSS believes an outcome of these continuing discussions and collaborations will be improved worker health and safety programs and the solidification of a safety culture at DOE sites.

Glenn S. Podonsky
Chief Health, Safety and Security Officer

HSS Visiting Speaker Program

The next phase of HSS outreach activities is the creation of the Visiting Speaker Program. The Visiting Speaker Program consists of presentations by leaders drawn from a variety of disciplines to include business, organizational theory, performance management, sustainability, and organizational resilience, made to HSS management and selected attendees from other interested organizations (i.e., Office of Science, Office of Environmental Management, and the National Nuclear Security Administration).

The program is intended to focus agency attention at the management level to the emerging challenges and issues threatening the national security and economic prosperity of the United States. DOE's mission, supported by HSS and other agency organizations, requires the most efficient and resilient leadership and organizational structure for successful mission completion and the continued safety, security, and prosperity of the nation. By inviting and having presenters from the wide range of public and private sector organizations, HSS is encouraging the transformation of government and demonstrating the various stages for change. This includes understanding the depth of the global issues, need for change, tools and means for transformation, and knowing the appropriate performance measurements to determine success and implement evolving management initiatives.

Panel Member: Eugene Arthurs

Eugene G. Arthurs joined SPIE staff as Executive Director in November 1999. Prior to this he was President and CEO of Cleveland Crystals Inc. (CCI) He joined CCI, a closely held company, in 1997 and after reorganizing the company he marketed and sold it at the end of 1998. He joined the Board of Gooch & Housego, PLC (G&H), the acquiring company, after the sale and oversaw CCI and Optronics Laboratories Inc., G&H's U.S. subsidiaries.

From 1983 to 1997, Eugene was with Oriel Corporation in Connecticut, initially as Vice President of Technology and Marketing and from 1991, as President. Oriel, originally a privately held corporation, was acquired by a venture capital company in 1987. He changed the business of Oriel to emphasize systems and instruments and in 1996 ThermoElectron Corp. acquired an increasingly profitable Oriel. Eugene became involved in Thermo's growth-by-acquisition activities. During his time at Oriel, he played an active role on the Boards of Oriel Scientific Ltd., (London, UK), LOT Oriel GmBH, (Darmstadt, Germany) and he was a founder of Andor Technology Ltd. (Belfast, N.Ireland) a company initially owned mostly by Oriel.

From 1980 - 1983, he was with Quantronix Corp., Smithtown, NY. He joined Quantronix as Applications Manager, developing medical and industrial laser applications and systems. In 1992, he took responsibility for Quantronix's dominant business segment, systems for semiconductor lithography and micromachining.

From 1975-1980, he was with Barr & Stroud Ltd. in Glasgow, Scotland. He established and led Barr & Stroud's Laser Group which designed and manufactured solid state lasers for medical applications and gas and dye lasers for scientific and industrial applications. After the acquisition of Barr & Stroud by Pilkington PLC, he worked extensively with Pilkington senior management on strategic planning. He was Research Associate at Imperial College London from 1973-1975, developing UV and gas lasers (for U.S. Air Force and UK Atomic Energy Authority contracts) and frequency conversion techniques.

Eugene received his B.Sc. (1st class honours) in 1972 in Physics, and his Ph.D. in 1975 in Applied Physics from Queens University Belfast, N.Ireland. His Ph.D. research was in generation and measurement of tunable ultrashort (1-2 ps in those days) pulses. In 1973, he taught the M.Sc. class in optoelectronics at Queens while continuing his research.

An SPIE member from 1972 or so, Eugene has been active in the American Society for Lasers in Medicine of which he was a founding member, the Council for Optical Radiation Measurement, and the OSA at a local and national level. He is currently a member of SPIE, OSA, CORM, CESSE, ASAE and the Advisory Board to the Photochemical Research Center at Bowling Green State University. A former Congressional District Organizer, he remains active in Bread for the World, an educational and public policy organization working on the basic causes of world hunger.

SPIE

Panel Member: Ron Ault

Prior to being elected as the Metal Trades Department's President, Mr. Ault served for four years as a General Representative of the Department. A former organizer with the International Union of Operating Engineers and a former business representative for the International Association of Machinists and Aerospace Workers, Ault is a career Labor Representative with more than 30 years experience.

Mr. Ault served a four-year enlistment with the U.S. Navy, including a tour of duty in Vietnam (1968-69). Mr. Ault went to work at the Norfolk Naval Shipyard in 1971; he was hired as an apprentice Inside Machinist. Graduating as a journeyman Inside Machinist with honors four years later, Ault served in various union positions. From 1980 to 1985, he served as president of the Tidewater Virginia Federal Employees Metal Trades Council and the Chairman of the Conference Committee at NNSY in Portsmouth, Virginia. Ault served as Campaign Coordinator in the Metal Trades Department's successful drive for union recognition at the Avondale Shipyard in New Orleans and was the Chief Negotiator for the historic first union contract at the yard.

Panel Member: Eric Mittelstadt

Eric Mittelstadt since January 2005 is the Chief Executive Officer of the National Council for Advanced Manufacturing (NACFAM), a leading industry led think-tank based in Washington, DC. Its mission is to broker the "Intense Collaboration" required to achieve NACFAM's vision for U.S. manufacturing; i.e., to make it sustainable and globally competitive based upon innovative practices & policies that continue to "Raise the Playing Field", not just level it. NACFAM does this in a non-partisan, non-lobbying way involving all stakeholders on researching and advancing policies in four focus areas; i.e., manufacturing process technology, workforce learning, supply chain value creation, and sustainable manufacturing.

Mr. Mittelstadt is also Chairman Emeritus of FANUC Robotics America, the leading industrial robotics company in the USA since 1984, and named one of "Michigan's 11 best companies to work for" in 1999. He headed that organization from it's startup as a joint venture between General Motors Corporation and FANUC LTD of Japan in 1982, first as President & Chief Executive Officer through August, 1997, and then as Chairman & CEO through December 1998, leading it to $370 million in revenue. Before that, his GM positions included Executive Assistant to the Group Vice President in charge of GM Overseas Operations, Managing Director in Uruguay, Truck & Bus Business Planning Director for GM Overseas, Product Planning Director in both Germany and Chevrolet, and various engineering and management positions at Chevrolet Division and the GM Corporate Engineering Staff.

Separately, Mr. Mittelstadt heads his own firm, Mittelstadt Associates, Inc., specializing in top management strategy and implementation consulting, especially concerning customer and employee satisfaction, team building and financial performance. He is a past member of the board of Ellison Technologies, Inc., a leading machine tool distributor, and of its Automated Concepts, Inc. subsidiary, a long time successful integrator of robotic systems for various industries.

Mr. Mittelstadt has served a number of volunteer organizations. He is a past Chairman of the NACFAM Board, and has been a member of the Board and chair of its Advanced Manufacturing Leadership Forum (AMLF). He has been a member of the Board of Directors of the Manufacturing Skill Standards Council (MSSC), and is currently on the Board of the Doyle Center for Manufacturing Technology in Pittsburgh and the Chicago Manufacturing Center, a part of the Manufacturing Extension Partnership.

Mr. Mittelstadt is listed in Who's Who in Manufacturing and Who's Who in Entrepreneurs. In 1992 he won the Joseph F. Engelberger Award for Robotic Industry Leadership. He is past chair of the USA Robotics Industries Association (RIA), the International Federation of Robotics (IFR), the Board of Control of Michigan Technological University, the Board of Trustees of St. Luke's Episcopal Health Ministries, and the South Oakland County Chamber of Commerce. He is a past member of the Detroit Regional Chamber of Commerce Board of Directors, the Oakland County Executive's Business Roundtable, Bloomfield Hills City Planning Commission, Cranbrook Schools Board of Governors, the Vestry of Christ Church Cranbrook, and president and board member of the Bloomfield Open Hunt.

NACFAM
NATIONAL COUNCIL FOR ADVANCED MANUFACTURING

Panel Member: Edward A. Morris

Ed Morris is currently the Director of Hardware and Manufacturing on the Lockheed Martin Corporate Engineering & Technology team. Reporting to the Vice President of Engineering, Ed works with the Lockheed Martin Business Areas to develop technical excellence, as well as a sound strategy for the hardware design and manufacturing communities across the Corporation. His focus is on improving the effectiveness of hardware design processes and methods as they influence the affordability, producibility, and testability of Lockheed Martin's portfolio of products and program execution. He is Vice Chairman of the Lockheed Martin Corporate Production Council. Additionally, Ed is responsible for developing and executing a proactive Lockheed Martin approach for Pb (lead)-Free Electronics.

Ed has a B.S. Degree in Aeronautical Engineering from Purdue University and an MBA from the University of Texas at Arlington. He has 37 years of defense, commercial and international aerospace industry experience with emphasis on program management, engineering, procurement, and manufacturing. Ed is a nationally recognized leader in advanced manufacturing technology.

Ed is the Chairman of the National Defense Industrial Association's Manufacturing Division, and is an active member the Technology Advisory Panel for the Next Generation Manufacturing Technology Initiative, the Penn State Electro-Optics Alliance, the joint industry/government Executive Lead-Free Integrated Process Team, the AIA-AMC-GEIA Lead-free Electronics in Aerospace Project (LEAP) Working Group, and the Missile Defense Agency's Transforming Defense Supply Chains Technical Advisory Board. Ed is a member of the Board of Directors for the National Center for Defense Manufacturing and Machining. He also serves as a member of the Industrial Advisory Boards for the Navy Electronics Manufacturing Productivity Facility, the National Science Foundation Industry/University Cooperative Research Center for Lasers and Plasmas, and the Center for Advanced Life Cycle Engineering (CALCE) Electronic Products and Systems Consortium at the University of Maryland. Ed is a member of the Aerospace Industries Association's (AIA) Engineering Management Committee. He is also an Industry Fellow for the University of Texas at Arlington Automation & Robotics Research Institute and a member of the Beta Gamma Sigma Honor Society.

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Panel Member: Jeffrey Q. Palombo

Mr. Palombo has executive responsibility for the overall growth and program activities for the division's diverse business portfolio. The Land Forces Division executes ~$1B/year in sales. The Land Forces Division is a diverse organizational specializing in land forces, communication systems and laser systems programs. The organization is comprised of approximately 1,500 employees based in multiples locations around the United States.

Mr. Palombo served as Vice President of Infrared Countermeasures (IRCM) for the Defense Systems Division with responsibility for the execution of all programs across the IRCM portfolion, including Directional Infrared Countermeasures, Large Aircraft Countermeasures, and the company's Guardian Counter Man-Portable Air Defense Systems, which features the Mini Pointer/Tracker missile detection system. Other activities he has been responsible for within Northrop Grumman include the development of complex laboratory simulation and open-air range simulation training systems for the United States Department of Defense and international customers.

Mr. Palombo earned a Bachelor's degree in Business and Marketing from Adelphi University. In addition, he has completed Hofstra University's Management Program in Government Contracts Administration as well as extensive coursework in Electric Engineering at the Polytechnic Institute of New York.

NORTHROP GRUMMAN

DEFINING THE FUTURE

Panel Moderator: Frank P. DiGiammarino

Frank P. DiGiammarino serves as Vice President of Strategic Initiatives at the National Academy of Public Administration. In this capacity, Frank supervises the conception and execution of special campaigns and initiatives and is responsible for driving strategic organizational change and opening new lines of business for the National Academy. Frank oversees the National Academy's communications, government relations and business development activities. Frank promotes the National Academy by developing innovative approaches to addressing government's management challenges. He has recently worked on studies for the Administrative Office of the Courts, Army Corps of Engineers, Equal Employment Opportunity Commission, and Immigration and Customs Enforcement.

An author and speaker on how to navigate government leadership transitions, Frank came to the National Academy in 2005 after many years as a senior consultant and strategist. Former positions include Director and DoD Practice Area lead at Touchstone Consulting Group, General Manager and Director of Program Management at Sapient Corporation, and Principal Consultant with the State and Local government practice at American Management Systems.

Career highlights include leading a program to re-engineer a $6 billion Army department with 15,000 personnel; driving reorganization of an 1100 person consultancy in 6 months with 85% adoption; and leading a 700+ person office that delivered $120 million in annual revenue. Frank holds a Bachelor of Arts in Political Science from the University of Massachusetts and Master's of Public Administration from The George Washington University. He serves on the Advisory Board for the Commonwealth College of the University of Massachusetts and the Advisory Board of the National Capital Area Chapter of the American Society of Public Administration. He is an advisor to the leadership team of the Young Government Leaders organization and has recently concluded serving as an advisor to the Change and Transformation Initiative at the George Washington University.

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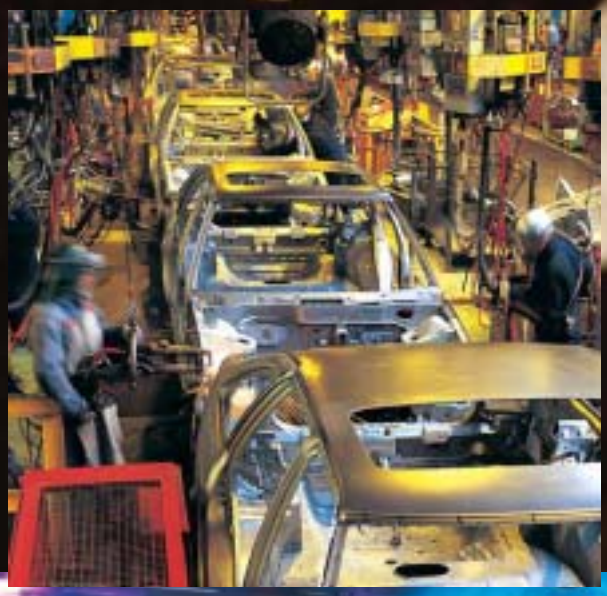
MANUFACTURING IN AMERICA

A Comprehensive Strategy to Address the Challenges to U.S. Manufacturers

U.S. Department of Commerce



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Message from the Secretary of Commerce

President Bush is committed to making sure every American who wants to work can find a job. In the third quarter of 2003, the U.S. economy grew at 8.2 percent—the strongest growth in nearly 20 years. Over the past five months, more than 250,000 new jobs have been created and the December 2003 unemployment rate of 5.7 percent was significantly below the 30-year average of 6.4 percent. Thanks to the President's pro-growth policies, America's economy is strong—and growing stronger.

The recent economic downturn hit the U.S. manufacturing sector particularly hard, but now our manufacturers are beginning to experience the benefits of the President's pro-growth policies. Factory activity is at its highest level in 20 years and new orders are at the highest level since 1950.

Strengthening American manufacturing is a top priority for the President. America's manufacturers provide our nation and our people with good jobs, a better quality of life, and inventions that have established our national identity. Manufacturing is the backbone of our economy and the muscle behind our national security.

To make sure the administration is doing everything possible to help American manufacturers, last year I ordered a comprehensive review of our manufacturing sector. Our goal is to help the American manufacturers compete and win in the 21st century. Through the Manufacturing Initiative, we will redouble the administration's efforts on behalf of the millions of Americans who work in the manufacturing sector.

The Initiative organized over 20 public roundtables to solicit input from American manufacturers. Our question was simple: How can government help manufacturers compete?

This report includes a series of recommendations aimed at unleashing the full potential of American manufacturers. It is an important first step toward strengthening American manufacturing and creating new jobs. In the coming weeks and months, the Department of Commerce will continue to work with manufacturers, other state and federal agencies, and Congress to help U.S. manufacturers become more competitive in the global marketplace.

American manufacturing has a rich history. After traveling the country and meeting with hundreds of factory workers, executives, and experts, I am confident it will have an equally rich future.

Donald L. Evans
Secretary of Commerce

Introduction

American manufacturers are a cornerstone of the American economy and embody the best in American values. They enhance U.S. competitiveness while improving lives domestically and internationally.

President Bush's concern for the men and women who work in manufacturing and the critical contribution they make to the U.S. economy is the driving force behind this report. Manufacturers are full partners in the effort to build the future of the country in the marketplace for new products and ideas. Simply put, a healthy manufacturing sector is key to better jobs, fostering innovation, rising productivity, and higher standards of living in the United States.

The United States is the world's leading producer of manufactured goods. Standing alone, the U.S. manufacturing sector would represent the fifth-largest economy in the world—larger than China's economy as a whole.[1] The U.S. manufacturing sector also leads in innovation, accounting for more than 90 percent of all U.S. patents registered annually.[2] Investments in technology create new industries and careers in manufacturing as U.S. firms introduce products and cutting-edge manufacturing techniques. Perhaps most importantly, productivity in manufacturing has continued to rise significantly.

Even as U.S. manufacturers engage in global competition with singular strengths, they also face unprecedented challenges. These challenges are both cyclical and structural. The most recent recession in the business cycle—a downturn that first began to be felt in 2000—hit U.S. manufacturers and their workers hardest. Output fell 6 percent in manufacturing even though the recession was relatively shallow overall. Employment fell by 2.6 million jobs in manufacturing, accounting for all of the net job losses from the fourth quarter of 2000 through the third quarter of 2003.

Today, as the overall U.S. economy expands strongly, much of the manufacturing sector continues to operate well below its previous peak. For example, while automobile production remains strong, many of the industries that support this production, such as the machine tools and tool and die industries, continue to lag behind the rest of the economy by a wide margin.

As difficult as the recession has been for U.S. manufacturers, the sector faces

even more significant structural challenges from the effects of rapidly changing technology and adjustment to a global economy. Barriers to trade have fallen rapidly over the past decade. Innovations in communications, computing, and distribution have accelerated the design, production, and delivery of goods. Improved production processes have spread rapidly throughout the world. Private investment now flows largely unimpeded across national borders as investors seek the highest rates of return. All these factors equate to unprecedented global competition for capital and markets. Because manufactured goods make up the bulk of international trade, the competition is especially strong. Taken together, the effects of technology and globalization accelerate the competitive pressures to lower costs and increase productivity.

The challenges facing U.S. manufacturers raise important questions for both industry and government. For industry, the question is how best to reinforce the sector's strengths and maintain its competitive edge in an increasingly competitive global economy. The competitive pressure on U.S. manufacturers has forced them to cut costs, to adopt lean manufacturing techniques, and to implement quality assurance programs that guarantee zero defects in production. Innovation in products, processes, and services has become a key determinant for success.

Fostering a competitive manufacturing sector also requires a different way of looking at government policy. The right policies in Washington, D.C.—and across the nation—can unleash the great potential of the U.S. economy and create the conditions for growth, prosperity, and job creation. For government, the ultimate question is whether the actions that it takes help or hinder American manufacturers as they compete in global markets. What steps should government take to create the economic conditions that foster a healthy and competitive manufacturing sector and spur economic growth? What are the best means of removing the impediments that government action has contributed to in the form of increased energy and healthcare costs and high or distortionary tax and regulatory compliance burdens that make it harder for U.S. manufacturers to attract investment and compete? How can government policy foster an environment in which American manufacturers and their workers are the best trained in the world? And, equally important, how can America ensure that success in the global marketplace is based on economic strength, rather than on government intervention that creates artificial advantages?

The Manufacturing Initiative

In a March 2003 speech to the National Association of Manufacturers in Chicago, U.S. Secretary of Commerce Donald Evans launched the Manufacturing Initiative to begin answering those questions. Secretary Evans called for a comprehensive review of issues affecting the competitiveness of the U.S manufacturing sector. The goal of the review was to develop a strategy designed to ensure "that the government is doing all it can to create the conditions" necessary to foster U.S. competitiveness in manufacturing and stronger economic growth at home and abroad.

Secretary Evans directed the U.S. Department of Commerce to seek the help of American manufacturers themselves in identifying the roots of the manufacturing sector's current challenges and the specific obstacles that government policy might pose to U.S. manufacturing competitiveness. To that end, the Department of Commerce held over 20 roundtable events with manufacturers, in which the advice of individual attendees was sought and obtained. These nationwide discussions included representatives from the aero-

space, auto and auto parts, biotechnology, semiconductor, chemical, pharmaceutical, plastics, and tool and die industries, among others. The manufacturers attending the roundtables represented a broad mix of small, medium-sized, and large companies, as well as minority-owned and women-owned enterprises.

To demonstrate Secretary Evans' commitment to meeting the challenges facing the manufacturing sector, the Commerce Department's senior managers led the roundtables,[3] with help from the Commerce Department's local Export Assistance Centers and private sector District Export Councils. Commerce Department industry specialists attended the roundtables to listen to and report on the discussions to Commerce Department leaders, thus ensuring follow-up action with any companies needing information or assistance.

In addition, the Commerce Department set up a Web site to gather and disseminate information regarding the initiative as broadly as possible. This Web site—*www.export.gov/manufacturing*—was used to provide information on events and activities, and to encourage those who could not attend the roundtables to contact the Commerce Department regarding manufacturing issues.

The process also benefited from discussions with industry association representatives who reflected a broad cross-section of the American manufacturing community. The Commerce Department received considerable help from both the personnel and member companies of the National Association of Manufacturers, Manufacturers Alliance/MAPI, Association for Manufacturing Technology, Society of Plastics Industries, Alliance of Automobile Manufacturers, National Tooling and Machining Association, American Forest and Paper Association, American Furniture Manufacturers Association, Motor and Equipment Manufacturers Association, Aerospace Industries Association, Association of Equipment Manufacturers, American Foundry Society, American Forest Products Association, and others.

The following report is divided into three chapters. The first chapter provides an overview of the domestic and international economic issues facing American manufacturing and identifies the powerful trends shaping the environment in which U.S. manufacturers compete today.

The second chapter draws on the experience of U.S. manufacturers themselves in identifying the challenges government must tackle. Small, medium-sized, and large manufacturers all stated that the first priority should always be to eliminate government policies and practices that hinder U.S. competitiveness. They identified immediate priorities such as spurring higher economic growth and creating incentives for investment, including research and development, as well as long-term efforts such as the reliability of energy supplies, reducing healthcare costs, and tort reform needed to reduce the indirect costs imposed on manufacturers by government action or inaction.

On the international front, manufacturers stressed the importance of breaking down the barriers that other governments erect against U.S. exporters and eliminating the practices that distort trade and investment. With respect to both finance and trade, manufacturers stressed that the goal of U.S. foreign economic policy should be to ensure that competition is free and fair. They also emphasized the need to reinforce U.S. trade promotion efforts in markets opened by recent trade agreements, particularly in China.

Manufacturers also emphasized the importance of looking to the future and investing in activities that have given U.S. manufacturers their competitive edge. In practical terms, that means ensuring that government does not impede

the development of new technologies that will create the industries and jobs of the future, as well as improving the competitiveness of America's existing manufacturing base. Manufacturers stated that this effort would require government research and development funding and the creation of a highly educated and motivated workforce.

The third chapter of this report sets out a series of recommendations designed to address the challenges identified by U.S. manufacturers. The recommendations represent a first step toward crafting the comprehensive strategy Secretary Evans called for in March 2003.

The recommendations respond to the call by U.S. manufacturers for a greater focus within the federal government on manufacturing competitiveness, including the creation of an Assistant Secretary of Commerce for Manufacturing and Services. President Bush announced on Labor Day 2003 that the creation of this position would help keep the federal government focused on issues relating to manufacturing and would drive the Manufacturing Initiative forward. The recommendations also address the challenges identified by U.S. manufacturers on both the domestic and international front, as well as reinforcing American manufacturing's competitive edge in the development of new technologies and a workforce that can meet the needs of modern manufacturing.

American manufacturers are enthusiastic about meeting the competition, but they need a fair international playing field and a domestic environment free from impediments to investment and growth

These recommendations represent the start of a process, not the end. From the outset, Secretary Evans has viewed this report and its recommendations as an opportunity to work closely with U.S. manufacturers to develop a sound strategy for American competitiveness in manufacturing. The Commerce Department intends to review these proposals with manufacturers across the country, to address the challenges identified, and to help set immediate priorities that will benefit American manufacturing.

In the meantime, the challenges confronting American manufacturers and manufacturing workers are urgent, and President Bush has already taken action. He has implemented a jobs and growth agenda and outlined a six-point plan:

1. To make healthcare costs more affordable.
2. To reduce the lawsuit burden on the U.S. economy.
3. To ensure an affordable, reliable energy supply.
4. To streamline regulations and reporting requirements.
5. To open markets for American products.
6. To enable families and businesses to plan for the future with confidence.

The necessity of acting on these reforms was reflected in the roundtable discussions: each proposal would improve the U.S. manufacturing sector's competitiveness in the years and decades to come.

One final point deserves emphasis. Despite the challenges faced by American manufacturing, there is one fundamental reason for optimism about the future of American manufacturing: the talent and motivation of the men and women who work in and manage America's manufacturing companies. More than anything else, manufacturers participating in the Commerce Department's roundtables expressed their commitment to roll up their sleeves and address the challenges they face in doing business in an increasingly global and competitive environment. American manufacturers are enthusiastic about meeting the competition, but they need a fair international playing field and a domestic environment free from impediments to investment and growth. This

report and its recommendations represent a commitment on the part of the Bush administration to foster an environment for the continuing success of American manufacturing.

Notes

[1] See "Total GDP 2002," World Development Indicators database, World Bank, July 2003.

[2] Jeff Werling, *The Future of Manufacturing in a Global Economy,* December 2003.

[3] They included Secretary Donald Evans; Deputy Secretary Samuel Bodman; Under Secretaries Grant Aldonas, Philip Bond, and Kathleen Cooper; Assistant Secretaries Linda Conlin, Bruce Mehlman, and David Sampson; Directors Arden Bement, Ronald Langston, and John Maxon Ackerly; and Deputy Assistant Secretaries Joseph Bogosian, Kevin Murphy, and Michelle O'Neill. Officials of the U.S. Department of Labor (including Assistant Secretary Emily DeRocco) co-hosted a roundtable focused specifically on workforce, education, and training issues, to which the U.S. Department of Education contributed as well.

Abbreviations and Acronyms

FDA Food and Drug Administration

GATT General Agreement on Tariffs and Trade

GDP gross domestic product

HSA health saving account

IRC Internal Revenue Code

ITA International Trade Administration

ITC International Trade Commission

MEP Manufacturing Extension Partnership

NAFTA North American Free Trade Agreement

NAM National Association of Manufacturers

NIST National Institute of Standards and Technology

NTMA National Tooling and Machining Association

OECD Organization for Economic Cooperation and Development

OEM original equipment manufacturer

OMB Office of Management and Budget

ONR Office of Naval Research

OSTP Office of Science and Technology Policy

PCAST President's Council of Advisors for Science and Technology

R&D research and development

R&E research and experimentation

SBA Small Business Administration

SBIR Small Business Innovation Research

STTR Small Business Technology Transfer

TRIPS Agreement on Trade-related Aspects of Intellectual Property

TPCC Trade Promotion Coordinating Committee

TPSC Trade Policy Staff Committee

USPTO U.S. Patent and Trademark Office

USTR Office of the U.S. Trade Representative

WTO World Trade Organization

One

Competing—and Winning—in a Global Economy

The following discussion sets out a framework for understanding the challenges identified by U.S. manufacturers. This chapter highlights the critical contribution manufacturing makes to the U.S. economy and details the many underlying strengths of the manufacturing sector.

The manufacturing sector's rapidly rising productivity is its greatest strength and a major contributor to the growth of the U.S. economy. Higher productivity offers multiple benefits: stronger competitiveness in manufacturing and other sectors of the economy, higher real wages, and a rising standard of living. That same productivity growth, however, has also been largely responsible for the gradual decline in employment in manufacturing: manufacturing employment has declined even as U.S. manufacturers have become more efficient both in absolute terms and relative to other sectors in the economy.

The manufacturing sector's overall performance in the past 25 years has been very strong, despite difficult periods of adjustment through the 1970s and 1980s. It remained strong despite shocks to the world economy, including those in some of the strongest U.S. export markets during the Asian financial crisis of 1997.

However, the manufacturing sector was hit by a particularly harsh recession in mid-2000, before the overall economy took a downward turn. Although rapid monetary and fiscal responses kept the recession in check, the cyclical changes flowing from the recession hit the manufacturing sector with unusual force.

In fact, the general economic downturn that first appeared in the manufacturing sector in mid-2000 may have masked the far more powerful underlying structural changes affecting manufacturing. With rapid advancements in technology, lower barriers to trade, and the entry of significant new competitors into global markets, the past five to 10 years have been marked by rapid change for America's manufacturers, even as they continue to adapt to the global market.

Importance of Manufacturing to the Economy

Manufacturing is crucial to the U.S. economy. Every individual and industry depends on manufactured goods. In addition, innovations and productivity gains in the manufacturing sector provide benefits far beyond the products themselves.

There is no dispute over the significant contribution that manufacturing

makes to the U.S. economy and to America's standard of living. The sector continues to account for 14 percent of U.S. GDP and 11 percent of total U.S. employment.

Those statistics, however, do not adequately convey the importance of the manufacturing sector to the U.S. economy and to America's future. Manufacturing is an integral part of a web of inter-industry relationships that create a stronger economy. Manufacturing sells goods to other sectors in the economy and, in turn, buys products and services from them.

Manufacturing spurs demand for everything from raw materials to intermediate components to software to financial, legal, health, accounting, transportation, and other services in the course of doing business. According to the Bureau of Economic Analysis, every $1 of final demand spent for a manufactured good generates $0.55 of GDP in the manufacturing sector and $0.45 of GDP in non-manufacturing sectors.[1]

The automotive sector provides a good example. The production of automobiles stimulates the demand for everything from raw materials in the form of coal and iron to manufactured goods in the form of robots to the purchase of services in the form of health insurance for the automobile companies' employees.

A healthy manufacturing sector is critical to America's economic future for other reasons as well—innovation and productivity.[2] Innovation holds the key to rising productivity, and productivity gains are the key to both economic growth and a rising standard of living.[3] As one leading economist put it:

A nation's standard of living in the long term depends on its ability to attain a high and rising level of productivity in the industries in which its firms compete.[4]

Rising productivity is the key to maintaining U.S. competitiveness in manufacturing, but the benefits of rising manufacturing productivity extend to the economy as a whole. For example, improvements in cotton harvesting equipment, manufactured in the Midwest, help improve the productivity of cotton growers in California and Texas. And expanding the power of computers makes on-line banking and other financial services possible.

A recent study by the National Institute of Standards and Technology reinforces how the benefits of improved manufacturing productivity extend to other sectors in the economy. The NIST study detailed the service sector's reliance on U.S. manufacturers for the goods and technology that spur service sector growth. It emphasized "the substantial dependency of services on manufacturing firms for technology" and the "critical role" manufacturing plays in stimulating growth in the services sector, which now makes up more than 70 percent of the U.S. economy.[5]

From the perspective of the average American worker, rising productivity translates into higher real wages and a broader range of higher-quality, lower-cost goods, meaning each additional dollar earned goes further. This makes it is easier to buy a home, save for a child's college education, or set aside money for retirement.

The manufacturing sector has generated many of the innovations that have led to significant productivity gains over the past 25 years in manufacturing and throughout the economy. Increases in manufacturing productivity have consistently outpaced other sectors of the U.S. economy. From 1977 to 2002, productivity in the overall economy increased 53 percent, while manufacturing sector productivity rose 109 percent. The greater than 50-percent increase in overall productivity represents a tremendous gain in the U.S. standard of living, and the more than 100-percent increase in manufacturing productivity is a remarkable achievement. As Figure 1 reflects, labor productivity in manufacturing has doubled since 1977. The rate of change has increased

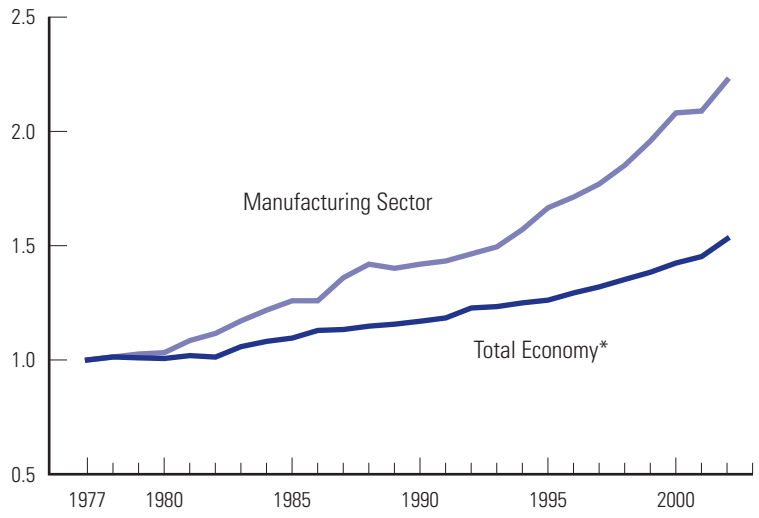
over time, with productivity growing faster (14.2 percent) in the past two and a half years, since the beginning of the last recession, than in any two-and-a-half-year period in the past 50 years.

Further, U.S. productivity strongly exceeds that of America's principal trading partners (Figure 2). The United States leads all countries in the absolute level of labor productivity, both per hour and per employee. This position has enabled the United States to maintain its labor cost advantage over these trade competitors despite the higher wages and benefits paid to American workers. The recently stronger performance of U.S. manufacturing in raising its productivity represents one of the causes for optimism for the sector's ability to adjust to rising levels of competition at home and abroad. The ability to raise productivity, even in the midst of recession and recovery, reflects that U.S. manufacturers have made changes in their operations and production methods to put themselves in a stronger position than manufacturers in other industrialized nations.

The growth in productivity has also had a profound effect on the U.S. standard of living. The 31-percent productivity advantage of the U.S. economy over OECD members accounts for three-quarters of the per capita income difference.[6]

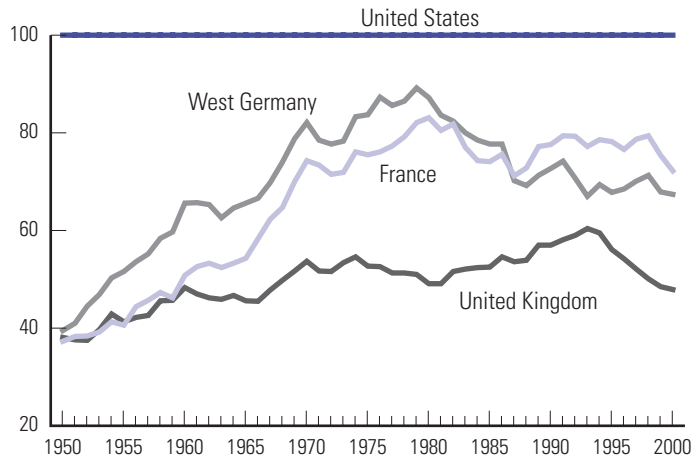
One important vehicle for the rising productivity in manufacturing has been technological innovation. In manufacturing, technological innovation comes in two forms. First, new inventions provide a leap forward in technology. Consider the first integrated circuits and the astonishing array of products that are directly related to its development. Many of those inventions derive from large investments in research and development in the manufacturing sector: manufacturing firms fund 60 percent of the $193 billion that the U.S. private sector invests annually in R&D.[7] Those technologies are absorbed by the much larger service sector and drive

Figure 1. **Productivity in Manufacturing and the Total U.S. Economy, 1977–2002**



* Excludes government and agricultural sectors.
Index: 1977 = 1.0
Source: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 2. **Per-Capita Manufacturing Output in Western Europe Relative to the United States, 1950–2000**

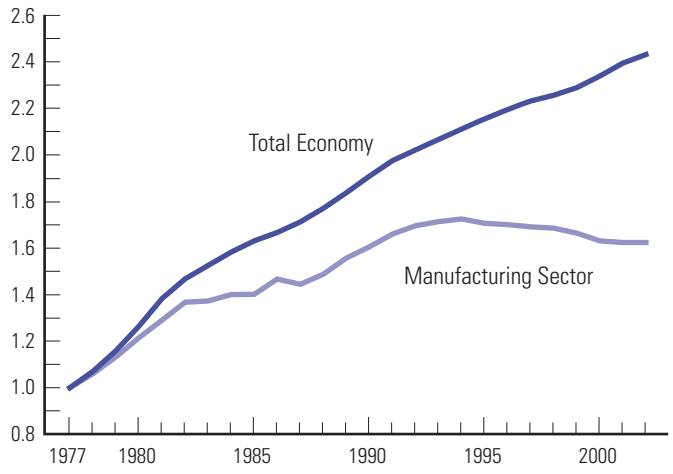


Index: U.S. level = 100
Note: "West Germany" data are for West Germany throughout, even after 1990.
Source: U.S. Department of Labor, Bureau of Labor Statistics; Groningen Growth and Development Center, International Comparisons of Output and Productivity by Industry.

the increasing rates of innovation and productivity growth in that sector.

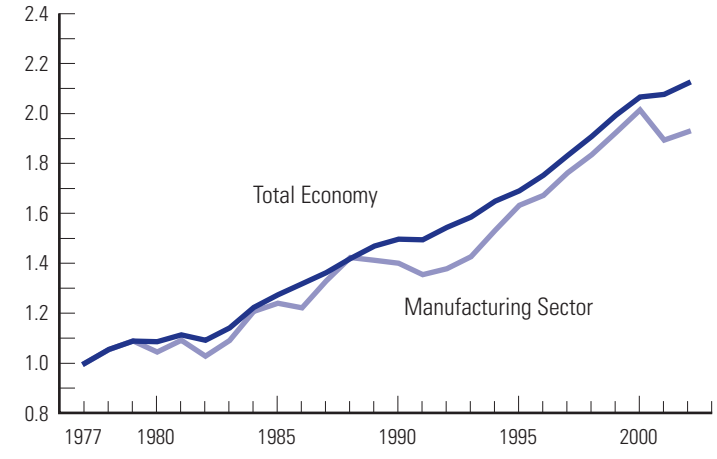
The other form of innovation comes from the steady improvement in products and manufacturing processes within major technology life cycles. Such improvement involves many less dramatic innovations, but collectively these innovations have a significant effect. For example, incremental improvements in the ability to etch a higher number of functions on a microprocessor or to multiply the number of calls a fiber-optic cable can transmit have a remarkable effect over time.[8]

Figure 3. **Prices in Manufacturing and the Total U.S. Economy, 1977–2002**



Index: 1977 = 1.0
Sources: Total economy: U.S. Department of Commerce, Bureau of Economic Analysis; manufacturing sector: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 4. **Output in Manufacturing and the Total U.S. Economy, 1977–2002**



Index: 1977 = 1.0
Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Both major and incremental innovations improve the competitiveness of the manufacturing sector and the U.S. economy as a whole. Because productivity has risen faster in manufacturing than in the services sector, prices of manufactured goods have risen more slowly than prices of services. At times, manufactured goods prices have even declined. That pricing pressure helps keep production costs in check for both the manufacturing sector and other areas of the economy.

In the past 25 years, prices in the overall economy have increased more than 140 percent, while prices in manufacturing have increased only slightly more than 60 percent (Figure 3). That also explains why manufacturing's share of nominal private output has declined from around 27 percent in 1977 to around 16 percent at present, even while the sector's contribution to real private output growth has remained roughly the same since 1977.

Real manufacturing output, adjusted for changes in prices, provides the best representation of manufacturing output over the past 25 years relative to the rest of the economy. Real manufacturing output since 1977 has grown nearly as fast as real output of the private economy as a whole (Figure 4).

Another way of measuring the similarity between manufacturing's growth in real terms and that of the broader economy is to look at the sector's contribution to the growth of real private output. Measured that way, the manufacturing sector's contribution has remained roughly steady at 0.6 percentage points for each 10-year

average annually from the 1977–1987 period to the most recent 1992–2002 period (Figure 5).

Compensation and Employment

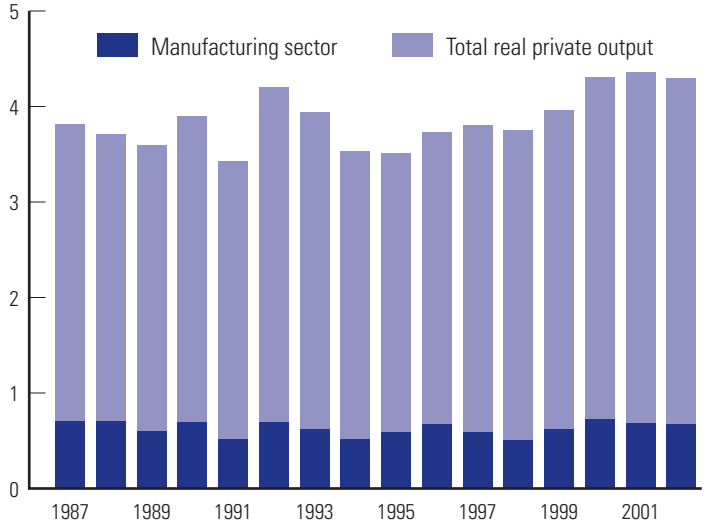
Historically, the manufacturing sector has had the reputation of providing a way for blue-collar workers to find good-paying jobs. Even today, the average hourly total compensation of production workers in manufacturing is higher than the average in all other sectors.

However, manufacturing's advantage in total compensation is based on benefits, rather than higher hourly wages. Average hourly earnings of production workers since 1967, when measured on an inflation-adjusted basis, suggest that manufacturing as a sector has offered an average, rather than high, hourly wage. There are, of course, specific sectors such as autos and steel that have offered wages far above the average, but these are balanced by others that have offered below average wages. In fact, the average hourly earnings in the wholesale trade, finance, and service sectors have surpassed those in manufacturing over the past 10 years; only retail trade remains lower.

The advantage of working in the manufacturing sector has derived, instead, from the higher level of average benefits received ($8.89 per hour for manufacturing versus $5.94 for non-manufacturing). Manufacturers contribute an average of $0.81 per hour more for health insurance, $0.66 more for overtime and supplemental pay, $0.62 more for leave, $0.29 more for retirement, and $0.34 more for other benefits (Figure 6).[9]

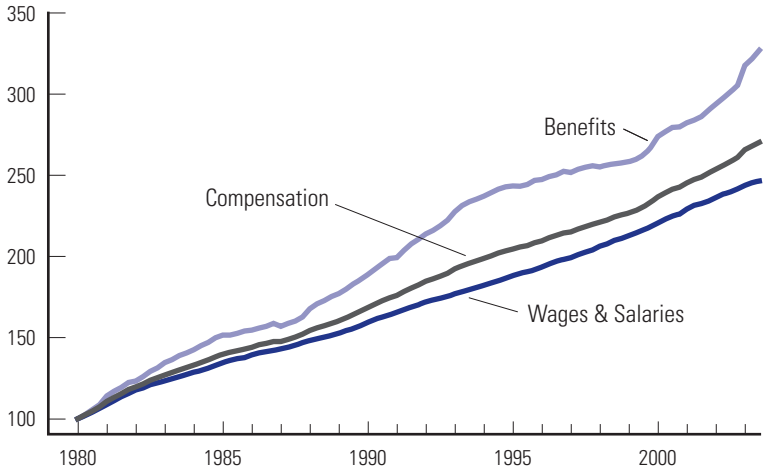
Because productivity gains in manufacturing have outstripped the growth in demand for manufactured goods, manufacturing employment has been falling for the past three decades. Manufacturing employment was significantly lower in 2002 than in 1977, falling from 22 percent of the non-farm economy to under 12 percent. Partial data for 2003 indicate

Figure 5. **Manufacturing as a Percentage of Average U.S. Private GDP Growth, 1987–2002** (Ten-Year Averages)



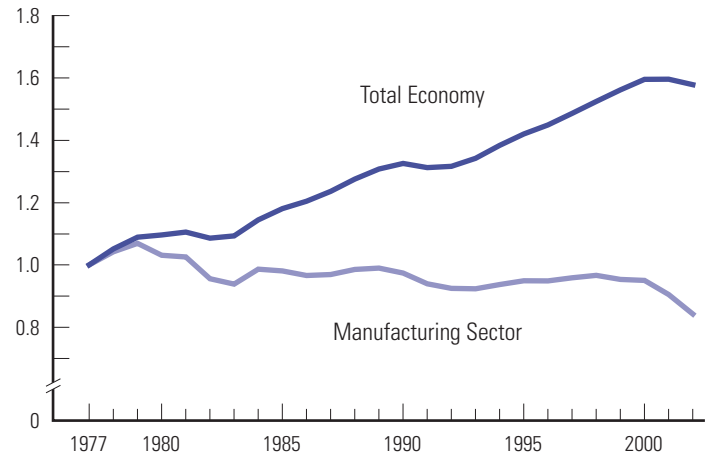
Note: "Total real private output" is the same as total real U.S. private GDP—that is , GDP minus the government sector. The top bars show the 10-year growth of private GDP, annualized to single-year averages. The bottom bars show 10-year moving averages: for a given year, contribution to private GDP growth by the manufacturing sector for that year is averaged with the previous nine years.
Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 6. **Employment Cost Index, 1980–2002**

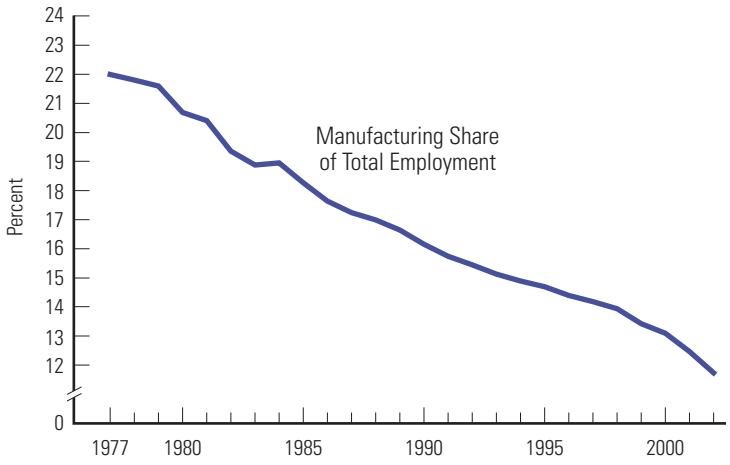


Index: 1980 = 100
Source: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 7. **Total Employment Growth and Manufacturing Employment Decline, 1977–2002**



Index: 1977 = 1.0
Source: U.S. Department of Labor, Bureau of Labor Statistics.



Source: U.S. Department of Labor, Bureau of Labor Statistics.

that the share has fallen further to about 11 percent (Figure 7).

Given that manufacturing represents a stable part of the economy while enjoying outsized productivity gains, the gradual decline in manufacturing employment is not surprising. Expressed another way, given the more rapid gains in labor productivity, manufacturing's share of total output would need to increase dramatically to maintain a given level of employment.

While the number of U.S. manufacturing jobs has fallen since 1979, other advanced economies have experienced the same trend. In the 1990s, manufacturing's share of employment fell at least as fast, if not faster, in Western Europe than in the United States (Figure 8).

On average, U.S. manufacturing employment has fallen 0.4 percent annually over the past 35 years. But that average rate of decline masks large fluctuations. Manufacturing employment rises and falls sharply in each business cycle. With each recession, manufacturing employment falls slightly lower than the previous trough. When the business cycle turns up and manufacturing firms begin hiring again, manufacturing employment rises, but it does not quite reach its previous peak.

These trends provide a useful transition to discuss the more recent developments in manufacturing.

Cyclical Effects of Recession and Recovery

After seeing prospects improve for more than a decade, American manufacturers have, in the past five years, faced harsh economic conditions. Recessions are typically hard in manufacturing. Of the eight recessions since 1950, real GDP has declined, on average, about 2 percent, whereas manufacturing output has declined 7 percent.

By the standard of overall output, the recession of 2001 was relatively mild;

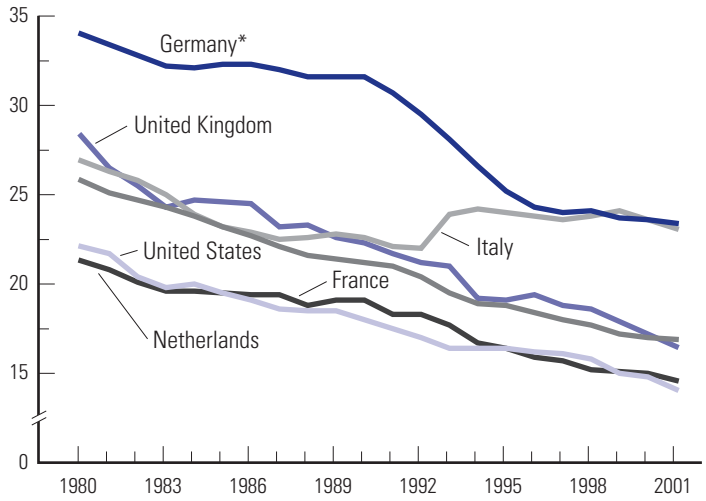
however, it hit the manufacturing sector particularly hard. Manufacturing output declined about 6 percent from the fourth quarter of 2000 to the third quarter of 2001, over which time real GDP fell 0.5 percent.

What has been striking about the most recent recession in manufacturing, however, was not the sharp drop in output, but the slow pace of recovery. In all but the most recent recession since World War II, manufacturing output has increased nearly 15 percent in the first two years of economic recovery. However, over the past two years, a period during which GDP rose nearly 6 percent, manufacturing output declined slightly (Figure 9). Total manufacturing production is still down some 4 percent below its previous peak of mid-2000.

The recession and the slow pace of recovery in manufacturing have been particularly hard on workers in manufacturing. Since the onset of the manufacturing employment downturn, the sector has lost 2.6 million jobs, while employment in other sectors has been relatively stable. In the third quarter of 2003, manufacturing employment remained 15 percent lower than in the period immediately before the recession. Perhaps more significantly, employment in manufacturing has fallen 8 percent since the recovery began. This decline was widespread across all manufacturing sectors (Table 1).

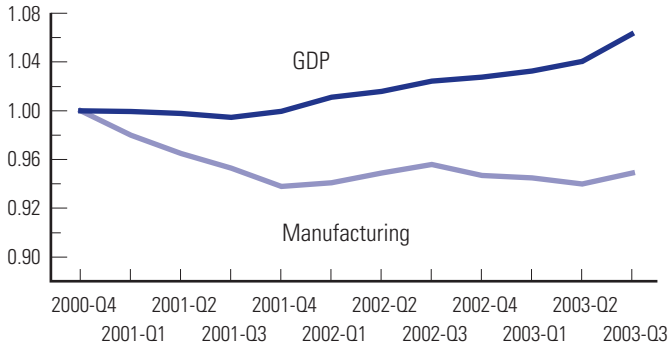
There were several features of the recent recession that made its effect on the manufacturing sector more pronounced. First, there was a significant retrenchment in business investment in technology following a surge in such investment throughout the preceeding decade. It is generally accepted that the high-tech sector spurred the economy in the late 1990s. High-tech production peaked, however, in late 2000 (Figure 10). Output in the sector declined 12 percent by the summer of 2001, decreasing considerably

Figure 8. **Manufacturing Employment as a Percent of Total Civilian Employment in Europe and the United States, 1980–2001**



* "Germany" data are for West Germany through 1990, and for unified Germany thereafter.
Source: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 9. **GDP and Manufacturing Output, 2000–2003**



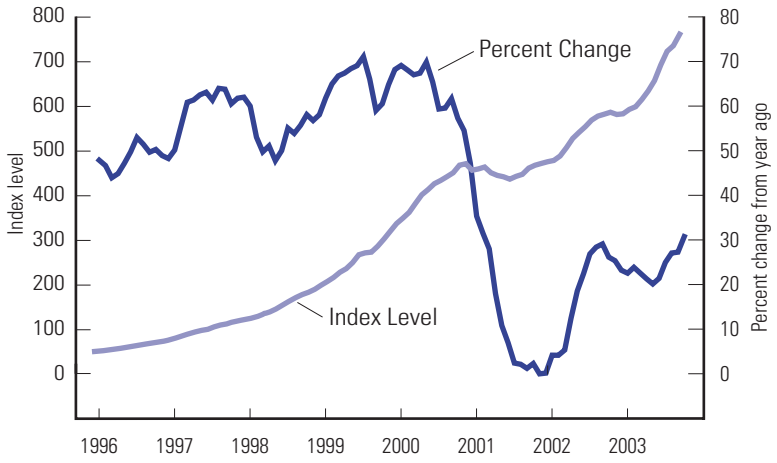
Index: Fourth quarter 2000 = 1.00
Sources: GDP: U.S. Department of Commerce, Bureau of Economic Analysis; manufacturing output: Board of Governors of the Federal Reserve System.

Table 1. **Net Change in Manufacturing Employment, Fourth Quarter 2000 to Third Quarter 2003**

	Percent	Number of Jobs
Total Manufacturing	**-15.1**	**-2,599,000**
Food	-1.8	-29,000
Beverage and Tobacco	-6.7	-14,000
Textile Mills	-29.5	-109,000
Textile Product Mills	-15.8	-34,000
Apparel	-37.4	-178,000
Leather and Products	-34.1	-22,000
Wood Products	-9.6	-57,000
Paper	-12.3	-74,000
Printing	-14.0	-113,000
Petroleum/Coal Products	-3.9	-5,000
Chemicals	-6.3	-62,000
Plastics/Rubber	-11.9	-112,000
Nonmetallic Minerals	-9.4	-52,000
Primary Metals	-22.7	-140,000
Fabricated Metals	-16.6	-293,000
Machinery	-19.6	-285,000
Computers and Electronics	-25.1	-467,000
Electrical Equipment	-21.3	-125,000
Transportation	-12.8	-260,000
Furniture	-15.5	-105,000
Miscellaneous	-8.6	-63,000

Source: U.S. Department of Labor, Bureau of Labor Statistics.

Figure 10. **High-Tech Industrial Production, 1996–2003**



Notes: High-tech industries are defined for this analysis as computers, communication equipment, and semiconductors.
Source: Board of Governors of the Federal Reserve System.

further than the average for the manufacturing sector as a whole.

The drop-off in high-tech spending that led the decline affected the high-tech sector worldwide. Data on global semiconductor sales, for example, indicate a sizable drop beginning in late 2000 and continuing for the next year as businesses spent considerably less on communications and computing technology (Figure 11).

Two manufacturing sectors that experienced among the largest percentage job declines were precisely those industries most affected by the decline in high-tech spending. Employment in computers and electronics fell 24 percent from the fourth quarter of 2000 to the third quarter of 2003, and the decline in employment in electrical equipment was of similar magnitude—23 percent. Both decreases were larger than the 18-percent average for manufacturing as a whole.

The second feature of the recession that deserves attention was the sharp drop in inventories that accompanied the downturn. Inventory imbalances are typical for recessionary periods. Demand falls, and excess inventory is left on the shelves. Businesses respond by cutting back orders, shipments, and production until demand returns.

In the most recent recession, businesses reacted to a modest increase in inventory-to-sales ratios during 2000 by cutting back production in 2001 to get supply under control. The extent of the resulting relatively drastic inventory liquidation was much more severe in the 2001 recession than it was in the 1990–1991 recession.

The third feature of the recession worth noting is the uncertainty caused by the events of September 11, 2001, which depressed investment and demand. In addition to the direct effects on demand for manufactured goods, the decline in the demand for services such as tourism had subsequent effects on other manufacturing sectors such as autos and aircraft.

A fourth feature of the recession is the extent to which slower growth at home was compounded by the effects of slower growth abroad, particularly the dramatic drop in U.S. manufacturing exports to our principal export markets. Stronger growth abroad helps cushion the effects of recession at home.

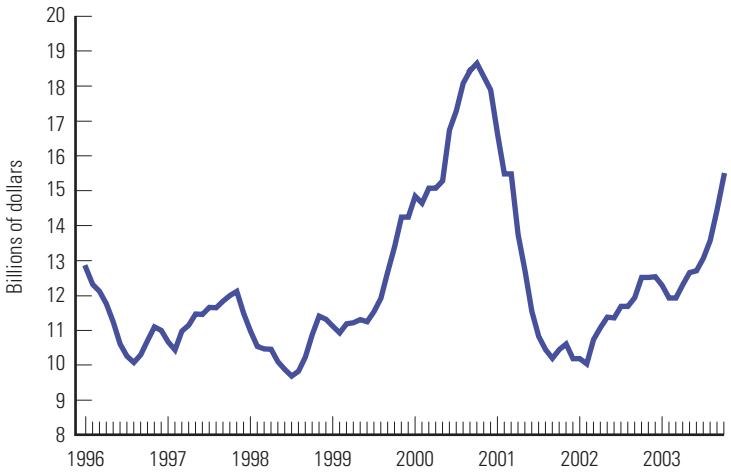
Unfortunately, although they have shown recent signs of growth, both Europe and Japan have grown considerably slower than the United States since the beginning of the recovery. Slower growth among the industrial economies has magnified the effect of slower growth in emerging economies in Asia since the onset of the Asian financial crisis in mid-1997. Although several Asian economies have recovered, the region's growth, with the principal exception of China, has yet to approach the levels reached before to the financial crisis.

Continued slow economic growth abroad produces less demand for U.S. manufactured goods than would otherwise be the case. Figure 12 covers a period that includes the last three U.S. recessions: in 1982, 1991, and 2001. The pattern of the most recent recession resembles that of the 1982 recession, which was marked by stagnation among America's major trading partners.

What the trend lines reflect is that the U.S. economy in general, and the manufacturing sector in particular, received little support from growth among major U.S. trading partners over the past two years.

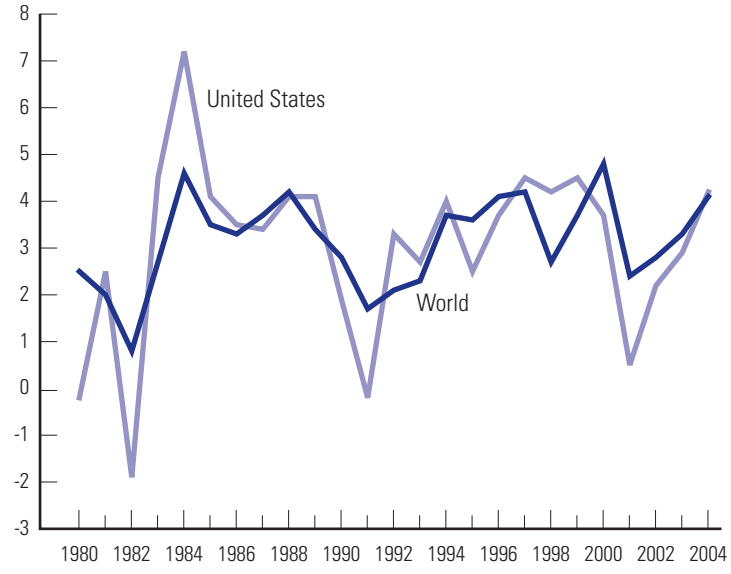
However, the U.S. economy as a whole has responded to both monetary and fiscal stimulus in the past year. The economy grew at an annual rate of 8.2 percent in the third quarter of 2003, which translates into stronger demand for all goods and services, including manufactures. In addition, there are signs of growing strength in a number of markets abroad. That stronger growth, combined with the continued competitiveness of the

Figure 11. **Worldwide Semiconductor Sales, 1996–2003**
(Billions of Dollars)



Notes: Data are based on a three-month moving average, wherein each month's sales figure is an average of its total sales and those of the subsequent two months. Data for 2003 are through October.
Source: Semiconductor Industry Association.

Figure 12. **Economic Growth: History and Forecast, 1980–2004**
(Percent Change)



Sources: World: International Monetary Fund; United States: U.S. Department of Commerce, Bureau of Economic Analysis.

U.S economy, has improved the prospects for exports of U.S. manufactured goods.

The manufacturing sector has recently begun to participate in the broader recovery under way in the U.S. economy. The Institute of Supply Management's Purchasing Manager's Index has remained above 50 (indicating continuing growth in future orders for manufactured goods) since August 2003.

Furthermore, rising productivity remains a bright light. Since the end of the recession, productivity in manufacturing is up 9.7 percent. Measuring from the period immediately before the recession, productivity is up 14.2 percent.

Those increases in productivity speak to the ability of American manufacturing to meet the competitive challenges and make a contribution to the rising standards of living in the economy. What the manufacturing sector can control—to invent, to innovate, and to combine resources to produce quality merchandise—it does quite well.

Structural Changes Shaping the Competitive Environment

With renewed growth in the U.S. economy, rising production numbers in the manufacturing sector, and significant gains in productivity even in the face of the recent recession, the manufacturing sector is poised for what could be a strong recovery. Nevertheless, the cyclical effects of the recession and the strengthening recovery are only part of the manufacturing story. In some respects, the recent recession has obscured the more fundamental structural changes under way in the manufacturing sector globally.

Over the past two decades, three separate, powerful trends have reshaped the manufacturing sector globally. The first is the revolution in technology that has been under way for two decades, raising productivity in manufacturing and reducing costs worldwide. The second is the significant reduction in barriers to trade, particularly with respect to trade in manufactured goods. The third is the end to political divisions that have segmented markets for more than 70 years and the corresponding emergence of Russia, China, and other countries in the world trading system. Each of these trends has significant implications for U.S. manufacturing, both in the form of new market opportunities as well as stronger competition.

Role of Technology

Global manufacturing has been fundamentally reshaped by the remarkable improvements in computing, communications, and distribution. Each factor, standing alone, would have greatly expanded the opportunities for trade, investment, and global production. Taken in combination, however, the rapid changes in all three influence many of the trends that have most reshaped manufacturing from the shop floor to the loading dock to the final customer. What these factors have also done is raise the bar to compete in today's manufacturing environment.

In 1987, in a review of the book *Manufacturing Matters*, Nobel Prize-winning economist Robert Solow famously observed, "You can see the computer everywhere but in the productivity statistics."[10] In the latter part of the 1990s, however, the evidence of the computer's effect on productivity finally surfaced. Compared with the relatively slow rates of productivity growth experienced between 1973 and 1995, labor productivity grew "roughly 1.2 percentage points [faster] a year from 1995 through 2000, a rise of more than 80 percent" above the previous trend line.[11] Investments in information technology are estimated to account for 60 percent of that increase in productivity.[12]

The dramatic expansion of computing power and its application to an ever greater range of tasks in the business environment is without a doubt the single most powerful technological change

affecting manufacturing today. Moore's Law—that computing power will double every 18 months—still prevails and is likely to continue for some time to come. One useful way to think about the explosion in computing power is the fact that the microchip in today's talking greeting cards contains more computing power than existed worldwide in 1945.[13]

Even skeptics of the contribution of information technology to productivity gains, such as Robert Gordon, generally have conceded its impact on manufacturing.[14] The increase in computing power touches every part of the manufacturing process. It has revolutionized product design by introducing computer-assisted design that allows much of the product development and testing to be done at a far lower cost in a virtual environment. Computing power has revolutionized manufacturing by creating a whole new family of multiple-axis machine tools that offer unmatched precision, quality, and efficiency.

Computers have also made possible most of the revolutions in business processes as well. In the absence of the computing power available today, concepts such as "just-in-time" production and "demand-pull" manufacturing processes could not exist in their current forms.[15] The dramatic increase in computing power has created an ever more powerful tool for developing new products, lowering production costs, raising quality, measuring performance, and managing business.

Communications technologies are essential to running high-performance manufacturing operations. New communications technologies create the ability to manage just-in-time inventories and demand-pull manufacturing. Real-time communication is critical to feeding information back into a system that is designed to yield zero defects. Interoperable communications systems provide opportunities for manufacturers and their customers to collaborate in product development.

Similarly, new communications technologies allow engineers to conduct real-time product development discussions with colleagues around the world. In addition to the videoconferencing capability, communications technologies use operating systems that allow anyone participating in the discussion to manipulate the same computer-generated design on the screen.

The revolution in communications has fundamentally changed the way manufacturers do business. Wireless communication means that a cellular phone and a laptop computer can replace a salesperson's office. Not only does the cellular phone allow for greater contact and consultation with customers about their needs, but it also contains the necessary functions to place an order and begin the manufacturing process directly from the point of sale.

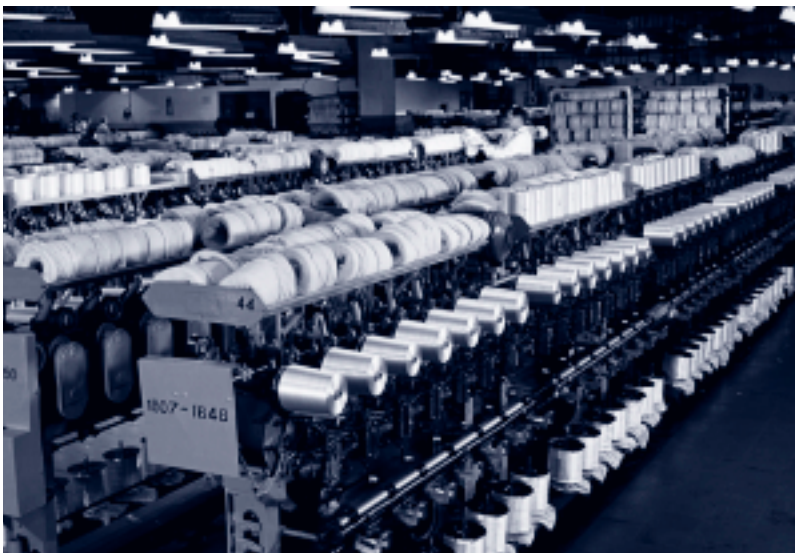
manufacturing has been fundamentally reshaped by the remarkable improvements in computing, communications, and distribution

The communications revolution has also significantly changed the delivery of finished goods to customers. For instance, in trucking, the combination of a global positioning system transmitter and a cellular phone has meant less waste, greater efficiency, and a lower cost to manufacturing customers. New communications devices also ease the distribution of goods by creating an interface with government agencies that may require information for security or regulatory reasons. By reducing the costs of distribution, new communications technologies have reduced the cost of the end products.

The application of technology has also transformed the distribution of manufactured goods and reduced the costs of transportation. Obviously, air travel has contributed much to making the competitive marketplace for manufactured goods a single market. In addition, significant changes in shipping since World War II, such as the rise of containerization and

roll-on/roll-off cargo allow for a smooth transition from container ship to rail to truck and dramatically increase efficiency. Distribution is also aided by new cargo handling facilities operated by express delivery services. For example, this enables computer manufacturers to operate overnight repair facilities and deliver repaired computers to their owners in fewer than 24 hours.

The combination of the trends in computing, communications, and transportation has generated a new service of door-to-door logistics. Logistics has become essential to meet the demands of



the market and has been fundamental in lowering the costs of manufacturing to remain competitive. The competitive environment has been reshaped by such advances, which grew out of post-World War II defense research.[16] The Office of Naval Research funded the research of a number of engineering professors at the nation's premier research institutions. Those professors had been instrumental in solving a wide range of practical technical problems attendant to the war effort during World War II and continued to receive ONR funds after the end of the war in 1945.

The post-World War II investment in R&D paid enormous dividends in the form of new products, new industries, and improved growth and competitiveness of U.S. manufacturing. But, increasingly, it is private industry that is making the investments driving innovation. By 1980, industry had become the lead investor in U.S. R&D activities, investing more than the federal government for the first time. Today, robust private sector investment in R&D outpaces federal R&D funding by a ratio of more than two to one, effectively reversing the ratio that prevailed throughout the Cold War and the space race.

The lesson that the post-World War II revolution in science and engineering in the United States flowed from investments in R&D was not lost on foreign nations. Today, nations everywhere recognize the link between technology, economic growth, and job creation. They are, as a consequence, increasingly establishing research institutes and key technology programs; creating incentives for partnerships among industry, academia, and government; and boosting training for scientists and engineers.

That dynamic is reflected in the sharp decline in the U.S. share of total world R&D spending. Through the 1960s, the U.S. share of global R&D ranged between 60 and 70 percent. Today, by contrast, the U.S. share is 30 percent.

Equally important is the proportion of a nation's output that is reinvested in R&D, as this ratio is an indicator of an economy's commitment to competing on the basis of new technology in the future. In this regard, the R&D intensity of the U.S. economy has remained essentially constant for 40 years, during which time the surge in foreign R&D investment has occurred.

The change in R&D funding patterns in technology has led to the broad dispersion of technology worldwide. The increase in foreign direct investment by many global firms has reinforced that

trend. Advanced, state-of-the-art manufacturing facilities capable of producing high-quality, low-cost goods are now available worldwide. American manufacturers face competition not only from manufacturers of low-cost commodity products, but also from manufacturers of sophisticated products and the tools to make them.

Thus, U.S. manufacturers will face constant pressure not only to lower prices, but also to increase the value that they add to their products. Competition from low-cost producers creates an incentive to move up the value chain in the direction of higher-margin goods, where the conditions of competition are not based on price alone. Increasingly, success in manufacturing will depend on the ability to integrate new technologies rapidly into both products and operations. That ability puts a premium on continuing R&D as the primary means of gaining a competitive edge.

Lowering Barriers to Trade

The second trend reshaping the environment in which U.S. manufacturers compete is the significant reduction in tariff and non-tariff barriers to trade in manufactured goods globally. Successive rounds of multilateral trade negotiations under the General Agreement on Tariffs and Trade and its successor, the World Trade Organization, for example, have cut the average tariff on manufactured goods worldwide by 30 percent. For industrialized countries the results are even more remarkable. According to a 1999 study published by the Organization for Economic Cooperation and Development, the average tariff rate for OECD countries, which was 40 percent at the end of World War II, is now 4 percent.[17] The more recent creation of free trade agreements, such as the North American Free Trade Agreement between the United States, Canada, and Mexico, has reinforced the trend. Over the past 10 years, NAFTA eliminated tariffs and many non-tariff barriers applicable to the largest three-way trade in the world.

The value of world trade has grown enormously as a result. Since the creation of the GATT system, world exports grew from $58 billion in 1948 to $5.98 trillion in 2001. According to data compiled by the WTO, the volume of world exports increased at a compound annual rate of 5.8 percent in the past 25 years alone, a pace that was more than twice as fast as growth in the world economy as a whole.[18]

U.S. manufacturers face considerably higher compliance costs than do many of America's trading partners

Most of the growth in world trade has been in manufactured goods. The sector now accounts for approximately three-fourths of all trade in goods and 60 percent of all trade, in goods and services combined.[19] One reason for the predominance of manufacuring trade is that the United States and its trading partners have reduced barriers to trade in manufactured goods further and faster than in other sectors. While trade in agricultural goods, for example, has grown at a relatively strong annual rate of 3 percent over the last 20 years, exports of manufactured goods advanced at nearly twice that rate, averaging 5.7 percent per year.

The growth in trade over the past 50 years, fueled by falling trade barriers, has contributed directly to the most rapid, sustained economic growth in U.S. history. Output in the United States increased fivefold and real GDP tripled. U.S. real GDP, expressed in 2000 dollars, grew from $11,672 in 1950 to $34,934 in 2002.

Trade continues to contribute significantly to U.S. economic growth. In the past decade alone—which included the creation of NAFTA, the conclusion of the Uruguay Round of GATT talks, and the creation of the WTO—world trade grew by 87 percent.[20] Between 1990 and 2000, U.S. exports were up 98 percent and the share of world trade represented by U.S.

exports actually grew from 11.4 to 12.2 percent.[21] In other words, rather than having a negative impact on the U.S. economy and manufacturing sector, the most recent round of trade agreements appears to have allowed U.S. exports to grow at a faster pace than world trade overall.

The U.S. economy grew rapidly over those same years, exceeding the pace of most other industrialized nations. From 1990 to 2002, the economy expanded at a 3-percent annual rate: the economy grew from $7 trillion in 1990 to $10 trillion in 2002.[22] During that time, the growth in U.S. exports accounted for one-sixth of all growth in the U.S. economy.[23] In sectors such as machinery, computers and electronics, and transportation equipment, exports now make up between 50 and 60 percent of all sales.[24] In one-third of U.S. manufacturing industries, exports account for one in every five manufacturing sales. According to the most recent figures available, exports now support more than 12 million jobs, and those jobs pay between 13 and 18 percent higher than the average U.S. wage.[25]

The benefits of trade, of course, flow from imports as well as exports. Reductions in tariffs on imports into the United States represent a cut in regressive taxes. This cut offers significantly higher benefits to low-income households than to those with higher incomes. By some estimates, NAFTA and the Uruguay Round agreements raised the average annual income of an American family of four by $1,300 to $2,000.[26] A further reduction in global barriers by just one-third would increase that family's annual average income by an additional $2,500 a year.[27]

The benefits from import competition are not limited to the final consumer. Access to the highest-quality, lowest-cost components is an essential element of the U.S. manufacturing sector's competitiveness. Imports stimulate competition and spur American manufacturing to increase its own quality and productivity. It is worth underscoring that during the past decade, while trade was expanding significantly, the U.S. manufacturing sector was growing faster and in more dynamic ways than it had in decades.

None of those results are surprising in economic terms. A more open economy has moved the United States toward the position of its greatest comparative advantage. This openness has brought about increasing returns and a more efficient use of resources. Both are consistent with stronger economic performance. Indeed, some of the latest research suggests that the broad engagement of the United States in the world economy—particularly the adjustment of the U.S. economy toward a more competitive state—has actually helped retain employment in the manufacturing sector that would have otherwise been lost.[28]

In fact, to the extent that other countries are currently examining the health of their own manufacturing sectors, they have identified the United States as the model. In its recent study of manufacturing in the United Kingdom, for example, the British government essentially benchmarked the U.S. manufacturing sector as the best measure of its own progress and policies.[29] Similarly, the European Union articulated a vision of aerospace manufacturing that expressly contrasted the development of their aerospace industry with that of the United States.[30] Many developing countries also use the United States as a model.

These developments point to the basic benefits to the U.S. economy, and to its manufacturing sector in particular, from participating in an increasingly open

trading system governed by a common set of rules. They also point to the benefits that can be derived, both for U.S. manufacturers and for the country, from the current effort to open markets through trade negotiations. Furthermore, vigorous enforcement of agreements is needed to ensure that U.S. manufacturers, together with the nation's farmers and service providers, receive the benefit of the bargains negotiated.

Given the concerns expressed throughout the U.S. manufacturing sector about the current trade rules, it is worth reiterating the extent to which the rules adopted in recent trade agreements have served, rather than undercut, U.S. economic interests, including those of U.S. manufacturers. Reducing tariff barriers, improving investment rules, and developing stronger intellectual property protections, for example, mainly benefit the small manufacturers that were previously locked out of foreign markets. While larger firms can afford to invest behind the "tariff wall" and have the resources, in many cases, to develop strategies for protecting their intellectual property, smaller manufacturers have generally had only two options: either export directly or sell to someone who exports.

In the aggregate, macroeconomic forces—rates of growth and relative prices—have the primary effect on our trade balance and help explain the trade deficit. These forces, combined with innovation and productivity, underpin our trade position over the long term.

On the other hand, from the perspective of individual firms, other factors can be seen as important in global markets and America's trade position. Continued trade deficits, combined with the very visible efforts by some countries to confer a competitive advantage on their firms, lead some U.S. manufacturers to question the fairness of our trade agreements and the basic tenets of U.S. trade policy.

The United States has led the way in reducing trade barriers worldwide and has, in past negotiations, proved willing to cut its tariffs and limit other forms of its own intervention in the market to a greater extent than a number of America's trading partners. While noting that there are significant exceptions, including in the manufacturing sector, the average U.S. tariffs on a trade-weighted basis are now less than 1.7 percent.[31] While many major industrial trading partners have also reduced their tariffs to comparable rates, in other parts of the world U.S. exporters still face heavy tariffs. In addition, the United States is far less likely to subsidize its manufacturers directly than is the case in many other countries.

the United States has led the way in reducing trade barriers worldwide

Wholly apart from the basic regulation of trade or the imposition of specific protective barriers lies the question of costs imposed by government. U.S. manufacturers face considerably higher compliance costs in labor, environmental, and other regulatory areas than do many of America's trading partners, particularly in the developing world.[32] But there is little doubt that the disparities in certain highly visible areas drive the perception of unfairness that permeates many of the concerns of U.S. manufacturers about the current trade rules.

In today's global economy, a policy of protection simply does not work. A good example is the tool and die industry. While the U.S. tool and die industry has sought protection from import competition, particularly from China, the industry was also among the most vociferous opponents of President Bush's imposition of tariffs on imports of steel into the United States in 2002. What the tool and die industry's position reflects is that protection invariably involves costs and can injure other U.S. industries, including many manufacturers. Instead, what U.S. manufacturers seek is simply to ensure

that the rules that apply to U.S. manufacturers apply to their competitors as well, especially in the case of competition with companies that benefit from heavy state intervention.

Overall, the U.S. economy has benefited from import competition, which has helped maintain the competitiveness of many manufacturing enterprises and has dampened inflation considerably. At the same time, however, stronger import competition has put extraordinary pressure on manufacturing industries, including steel, furniture, tool and die, foundry products, textiles and apparel, and automotive parts, while touching advanced technology sectors as well.

what U.S. manufacturers seek is simply to ensure that the rules that apply to U.S. manufacturers apply to their competitors as well

Increasingly, competition in manufactured goods has been driven by the evolution of low-cost competitors in emerging Asian markets. In 1980, the United States, together with the European Community and Japan, dominated trade in manufactures, accounting for nearly 75 percent of the value of world manufactures exports according to WTO statistics. By 2001, however, that share had fallen by almost 15 percentage points, to 60 percent.

Emergence of New Competitors

The third powerful trend affecting the manufacturing sector globally is both political and economic. It involves the increasing reliance of other countries, notably China and the nations of the former Soviet Union, on market mechanisms, rather than government planning, as the principal means of structuring their economies.

Though not often thought of in trade terms, the economic consequences of the end of the Cold War may have had the most profound effect of all. The end of the Cold War marked the end of political and economic divisions that had split the world in one way or another since the onset of World War I. Even with the rapid changes in technology and the reduction of tariff and non-tariff barriers to trade, the global economy would not be possible if those divisions still existed.

The numbers bear this theme out. While the so-called Asian tigers' share of world trade grew rapidly over the past 20 years, the biggest gains in share of world trade in manufactures were captured by China. China's manufactured exports increased from only 0.8 percent of world shipments in 1980 to 5.3 percent in 2001. With the onset of economic reforms in 1979 and a heavier reliance on market forces, China has rapidly expanded its trade in manufactured goods. China now ranks fourth among exporters of manufactures worldwide.

It is worth underscoring that virtually all of the market share gains of China and other Asian nations have come at the expense of Japan and Europe, while the U.S. share of world exports of manufactured goods actually increased marginally between 1980 and 2001, from 13 percent to 13.5 percent.[33] That increase, in turn, is due to the ability of U.S. manufacturers to raise their productivity significantly over the same period. At the same time, however, U.S. manufacturers in a variety of sectors were seeing their share of the U.S. market eroded.

There is another side to the political and economic revolution that has taken place over the past two decades; any form of economic restraint has the effect of creating imbalances between demand and supply. Consequently, when those restraints are removed, capacity often exceeds demand, and the markets must adjust to bring supply and demand back into equilibrium.

The end of the Cold War and China's reentry into the world economy had a similar effect. A recent study of trends in manufacturing employment illustrates this. The study showed that manufactur-

ing employment has fallen not only in the United States, but also around the world.[34] In fact, China's manufacturing employment has actually fallen faster than that of the United States in percentage terms in recent years.[35]

This decline in employment largely reflects the gradual privatization of China's many state-owned enterprises and the subsequent reduction in employment as they adjust to competing in world markets. However, it also underscores the effect of rising global productivity and the extent of the excess capacity in manufacturing that continues to put downward pressure on the price of manufactured goods worldwide.

Shift toward Global Outsourcing

The practical effect on U.S. manufacturers of the three trends described above has been to increase the availability of new sources of low-cost labor and manufacturing capacity. Indeed, the trends have not only made it available, they have also made it an important competitive issue. In a global economy in which both goods and capital are mobile, but labor is not, manufacturers' tapping of lower-cost labor by importing it in the form of lower-cost parts, components, and—increasingly—finished goods is simply a function of trying to stay competitive in a global economy.

Hence, the trend toward sourcing parts and components globally is driven by powerful competitive forces and is here to stay. Manufacturers now have the ability to manage global supply chains effectively, which allows them to source from the lowest cost supplier globally and, as a competitive matter, forces them to do so in order to remain competitive themselves.

In an increasingly global market for manufactured goods, competition will largely take place among supply chains, rather than between individual manufacturers. That implies an entirely different concept of manufacturing. Rather than focusing on what traditionally defined manufacturing—that is, the process of turning raw materials into components or finished products—manufacturers today think of manufacturing as a system designed to perform the activities required to deliver the end-product to the customer and meet the customer's needs, from design to finance to production to sales and marketing to after-sales service.

Thought of in that way, the structure of manufacturing no longer implies that all of those processes need take place in a single enterprise. Manufacturers increasingly see themselves as system integrators, managing a supply chain or "virtual network" that may consist of any combination of the activities mentioned above, whether or not provided by the "manufacturer" itself.

Adapting to this changing competitive environment has forced U.S. manufacturers to adopt new production, marketing, and management methods, from "lean manufacturing" techniques, to quality assurance programs that guarantee zero defects, to international product standards so their goods can be incorporated in other firms' global supply chains. It also means an increasing demand to reach out to customers worldwide in order to show how a manufacturer can add value to the customer's product and its supply chain.

competing in a global marketplace puts a premium on government getting the economic fundamentals right to create an environment in which U.S. manufacturing can flourish

The automotive sector provides a case in point. Whereas U.S. automobile manufacturers once provided a ready market for many domestic suppliers of parts and components, the manufacturers now operate on a global basis. Thus, automotive parts suppliers must now find niches in the global supply chains of U.S. auto companies or their foreign competitors to succeed in today's market. That brings

U.S. auto parts suppliers into head-to-head competition with parts suppliers worldwide. The possibility of relying on increased auto sales in the United States that automatically translate into increased orders for parts and components for U.S. suppliers simply no longer exists. Competition now takes place on a global basis, and that fact will continue to shape the prospects for the manufacturing sector in the future.

The Government's Role: Getting the Fundamentals Right

The changing nature of competition requires, correspondingly, a different way of looking at government policy. This means fostering an economic environment, both domestically and internationally, that encourages growth, rewards sound investment, controls costs, and fosters innovation and rising productivity. It also means an aggressive international economic policy that ensures a level playing field by reducing barriers to trade and investment and vigorously enforcing the trade rules when violated.

Competing in a global marketplace puts a premium on government getting the economic fundamentals right to create an environment in which U.S. manufacturing can flourish. It means examining whether the U.S. government's actions and the structure of the U.S. market improve or hinder the ability of American firms, in manufacturing and throughout the economy, to compete in an increasingly global marketplace.

Notes:

[1] Bureau of Economic Analysis, U.S. Department of Commerce (2002). Calculations based on total requirements matrix from the BEA Web site, *www.bea.doc.gov*. Considered on an aggregate basis, total manufacturing shipments in the most recent 12-month period were $4 trillion, but only roughly 40 percent of this was value added in the manufacturing sector. The rest was either duplicate shipments as goods were shipped from one manufacturing processor to another, or inputs from other sectors-agricultural products into food manufacturing, crude petroleum into petroleum refining, and iron ore into steel manufacturing, as well as contributions from the transportation, financial, and business services sectors.

[2] Productivity is defined as the amount of goods and services produced, adjusted for inflation, per hour of work.

[3] See, for example,William J. Baumol, *The Free-Market Innovation Machine—Analyzing the Growth Miracle of Capitalism* (Princeton, N.J.: Princeton University Press, 2002); see also Michael E. Porter, "Building the Microeconomic Foundations of Prosperity: Findings from the Microeconomic Competitiveness Index" in *The Global Competitiveness Report* (Geneva: World Economic Forum, 2003).

[4] Michael E. Porter, *The Competitive Advantage of Nations*, 1st ed. (New York: The Free Press, 1990).

[5] Gregory C. Tassey, *R&D and Long-Term Competitiveness: Manufacturing's Central Role in a Knowledge-Based Economy*, Planning Report 02-2 (Gaithersburg, Md.: National Institute of Standards and Technology, February 2002).

[6] R. McGuckin and B. van Ark, *Productivity, Employment, and Income in the World's Economies* (New York: The Conference Board, 2002).

[7] Thomas J. Duesterberg and Ernest H. Preeg, eds., *U.S. Manufacturing: The Engine for Growth in a Global Economy* (Westport, Conn.: Praeger, 2003).

[8] Baumol, *Free-Market Innovation Machine*. Baumol makes that point a central theme in his recent work on the determinants of economic growth. He finds that "the social benefits contributed by the initial innovations are typically smaller than those provided by the accumulation of subsequent incremental improvements." Baumol points to the rapid improvement in performance and reduction in the cost of computers, which is largely attributable to the incremental improvements in production technology, rather than a quantum leap in the form of an entirely new way of computing.

[9] U.S. Department of Labor, Bureau of Labor Statistics, "Employment Cost for Employee Compensation" (Nov. 25, 2003).

[10] Robert Solow, review of Stephen Cohen and John Zysman, *Manufacturing Matters: The Myth of the Post-industrial Economy* in *The New York Times Book Review* (July 12, 1987).

[11] Roger E. Alcaly, *The New Economy* (New York: Farrar, Straus, and Giroux, 2003).

[12] Ibid.

[13] Diane Coyle, *The Weightless World* (Cambridge, Mass.: MIT Press, 1998).

[14] Robert Gordon, "Technology and Economic Performance in the American Economy," National Bureau of Economic Research Working Paper, no. 8771 (February 2002).

[15] *Economic Report of the President* (January 2001).

[16] Ibid.

[17] Organization for Economic Cooperation and Development, *Post-Uruguay Round Tariff Regimes: Achievements and Outlook* (Paris: OECD, 1999).

[18] World Trade Organization, *International Trade Statistics* (Geneva: World Trade Organization, various editions).

[19] World Trade Organization, *International Trade Statistics 2002* (Geneva: World Trade Organization, 2002).

[20] International Monetary Fund, *Direction of Trade Statistics* (Washington, D.C.: International Monetary Fund, 1981–2002), data from various editions.

[21] Ibid.

[22] U.S. Department of Commerce, Bureau of Economic Analysis.

[23] Ibid.

[24] Bureau of the Census, Annual Survey of Manufactures and foreign trade data in the FT 900 releases for 2001and 2002.

[25] U.S. Department of Commerce, Economics and Statistics Administration, "U.S. Jobs Supported by Goods and Services Exports, 1983–94," staff research report, November 1996.

[26] Drusilla K. Brown, Alan V. Deardorff, and Robert M. Stern, "Computational Analysis of Multilateral Trade Liberalization in the Uruguay Round and Doha Development Round," Discussion Paper no. 489 (Ann Arbor, Mich.: Research Seminar in International Economics, 2002).

[27] Idem, "Multilateral, Regional, and Bilateral Trade-Policy Options for the United States and Japan," Discussion Paper no. 490 (Ann Arbor, Mich.: Research in International Economics, 2002).

[28] Lori G. Kletzer, "Imports, Exports, and Jobs: What Does Trade Mean for Employment and Job Loss?" unpublished paper for the W.E. Upjohn Institute for Employment Research, December 2002.

[29] United Kingdom, Department of Trade and Industry, *Manufacturing—a Sector Study; the Performance of Manufacturing Companies within Benchmark Index* (Staffordshire, England: Benchmark Index, 2002).

[30] European Commission, *Star21: Strategic Aerospace Review for the 21st Century* (Brussels: European Commission Enterprise Publications, 2002).

[31] U.S. International Trade Commission calculations for all goods in 2002, including preferences. Examples of exceptions in the manufacturing sector include tariffs over 50 percent for certain footwear and over 30 percent for certain apparel.

[32] Jeremy A. Leonard, "How Structural Costs Imposed on U.S. Manufacturers Harm Workers and Threaten Competitiveness," NAM/MAPI study, December 2003.

[33] World Trade Organization, *International Trade Statistics, 2002*.

[34] Joseph G. Carson in Alliance Capital's *U.S. Weekly Economic Update* (October 2003).

[35] Ibid. China's manufacturing employment declined by 15 percent from 1995 to 2002, while U.S. manufacturing employment declined 11 percent over the same period.

Two

Identifying the Challenges Facing American Manufacturing

This chapter highlights the challenges facing the U.S. manufacturing sector, as expressed by manufacturers themselves through the Department of Commerce roundtables. It also seeks to capture the priority issues that manufacturers believe need to be addressed in a comprehensive strategy to ensure the competitiveness of U.S. manufacturing. The views reflect a common understanding of the trends outlined in Chapter 1 that likely will shape the competitive environment for manufacturing. Manufacturers also recognized the basic strengths of the U.S. manufacturing sector as it meets the challenge of competing in a global economy.

If there was one underlying theme that emerged in the roundtables, it was the understanding that fundamental adjustments are under way throughout the global manufacturing sector. Manufacturers asked for an increasing focus by government on these adjustments and wanted to ensure that government was taking the steps necessary to create an economic environment in which U.S. manufacturers could succeed.

Toward that end, manufacturers attending the Commerce Department's roundtables outlined six areas that require immediate attention:

1. Manufacturers perceived a lack of focus within government on manufacturing and its competitiveness. Manufacturers are looking for a commitment to understanding the challenges that the sector faces in competing in a rapidly globalizing economy. They want government to take the steps needed to foster the manufacturing sector's ability to adjust to that new competitive reality.

2. Manufacturers want the government to focus on encouraging stronger economic growth both at home and abroad. There is a broad understanding that the recent recession was led by a sharp drop in business investment and that both monetary policy and fiscal policy have worked to set the economy on the route to recovery. But there are still steps that manufacturers feel are necessary to encourage business investment, and to reinforce the recovery under way in the economy as a whole and in the manufacturing sector in particular.

3. Manufacturers see the need for government to match the effort that they have made in controlling manufacturing costs. As manufacturers have focused on reducing costs to improve productivity and ensure their competitiveness, they often find their efforts eroded by costs they cannot control—costs that result in

part from government policy. Manufacturers seek a commitment on the part of government to reduce those costs and, in the process, create an economic environment that is attractive to investment in manufacturing within the United States.

4. Manufacturers emphasized that enhancing America's technological leadership was critical to their future. There is widespread recognition that the United States remains the world's leader for investment in research and development, and that U.S. investments in technology have paid significant dividends in current manufacturing competitiveness. It is also understood by U.S. manufacturers that technology is now more widely diffused throughout the world economy and that this trend risks eroding what has become the principal competitive advantage of the United States. What manufacturers seek is a commitment to encourage research and development and to ensure that the government reinforces, rather than creates obstacles to, the process of bringing innovations to the marketplace.

5. Manufacturers regarded education as crucial. Manufacturers are extremely interested in addressing the shortcomings of the U.S. educational system. Roundtable participants underscored that the evolving nature of the manufacturing sector relies on individuals entering the workforce with greater problem-solving abilities. These workers must continually sharpen their skills through lifelong learning. In addition, roundtable participants expressed concern that the United States risks losing an innovation infrastructure if the nation fails to produce scientists and engineers. Manufacturers seek a renewed emphasis from all levels of government to invest in educational and training institutions.

6. Manufacturers also focused on the need for international trade and monetary policies that ensure that global competition in manufacturing is free, open, and fair. Many manufacturers expressed concerns regarding China. What manufacturers seek is not protection from competition, but the ability to compete on equal terms. Toward that end, they strongly support leveling the playing field internationally by lowering barriers to trade and eliminating efforts by foreign governments to confer unfair competitive advantages for their manufacturers.

The following discussion explores each of those themes.

Focusing on Manufacturing and Its Competitiveness

At every roundtable, U.S. manufacturers made the point that, although the manufacturing sector represents a cornerstone of the U.S. economy, manufacturing receives scant attention from the public or government. To many manufacturers across the country, it appears that the public and government have lost sight of a simple truth: you cannot have good jobs if you do not have strong businesses.

That thought was articulated by Phyllis Eisen of the National Association of Manufacturers at a roundtable held in Washington, D.C. She summed up her conversations with "teachers, educators at all levels, with kids from seventh grade through university, with their parents, with politicians, and with our own manufacturers," with this statement:

The information we got is not good about manufacturing. It is invisible to most people. They don't equate the table and the spoon they use and the glass they use . . . with this extraordinary industrial strength that we've had for so many years and that we have to maintain.

Some roundtable participants went further, describing what they saw as a pervasive bias against manufacturing, based on an old assembly-line image, causing the best and the brightest to pursue careers outside the manufacturing sector. At the roundtable in New Britain, Conn.,

Bruce Thompson of Projects Incorporated noted that manufacturing had evolved in ways most people did not know or appreciate. He emphasized that "people need to get out and see that it's not a dirty, oily, old mess anymore. It's technicians running high-precision equipment."

The roundtable participants attributed some of the public's misperception about manufacturing to the lack of focus in government on manufacturing. They pointed out that there was no single advocate for manufacturing within the executive branch departments. "I think the United States is the only country in the G8 which doesn't have a very-high level department of manufacturing," said Bob Brunner of Illinois Tool Works at the Rockford, Ill., roundtable. "I think that [establishing such a department] would be a real positive development in terms of supporting us manufacturers."

Manufacturers expressed frustration that there was no focal point for the many programs that government supports at the federal, state, and local levels to assist manufacturers. Bruce Thompson pointed out that there was no "seamless interface." What was needed, in his view, was "a one-stop shopping mentality," so that manufacturers do not have to call on a lot of different organizations to get the information and assistance that they need. As Von Hatley of the Louisiana Department of Economic Development put it at a roundtable in New Orleans, "We really need a concerted effort between federal and state [governments] to do what it takes to save manufacturing." To ensure accountability, manufacturers sought the establishment of a single office within government with responsibility for implementing the Manufacturing Initiative.

Historically there has been little institutional focus on manufacturing in the federal government. Although various agencies take into account elements of manufacturing competitiveness, in practice there is no mechanism to coordinate these efforts. While it is widely understood that the Commerce Department serves as the principal advocate for manufacturing's interests, there is no office in the Commerce Department that is solely responsible for looking out for the competitiveness of U.S. manufacturing.

Many roundtable participants thus requested the establishment of a manufacturing-related position within the Commerce Department at the assistant secretary level or higher to focus on manufacturing competitiveness and the health of the manufacturing sector in general. Manufacturers also urged stronger coordination both within the federal government and with state and local governments to foster investment in manufacturing, as well as requesting a regular dialogue between government and the manufacturing sector on its competitive challenges.

manufacturers sought the establishment of a single office within government with responsibility for implementing the Manufacturing Initiative

The administration has therefore proposed creating an assistant secretary for manufacturing and services who would develop and implement a comprehensive strategy on manufacturing. While maintaining a focus on manufacturing, strategic planning must include the service sector, which both influences and benefits from the manufacturing sector's competitiveness.

This new position would provide the focus within the Commerce Department needed to respond to manufacturers' concerns. The assistant secretary's office would be able to provide regulatory economic analysis essential to assessing the costs and benefits of government action on manufacturing competitiveness. This office would be charged with establishing a mechanism for coordinating manufacturing-related initiatives among the various executive branch agencies and would

enhance the Commerce Department's ability to ensure that focus on a government-wide basis.

The Need for Stronger Economic Growth at Home and Abroad

Manufacturers attending the roundtables indicated that the single most important economic policy objective from their perspective was encouraging economic growth. Stewart Dahlberg of J.D. Street & Co. described the reality of the global marketplace at the St. Louis, Mo., roundtable:

The world is a very big place. There are lots of customers out there and lots of niche customers to find. What we would . . . simply ask [is] that every possible opportunity to open up every single possible market be investigated and called out anywhere you can.

American manufacturers, both large and small, understand the value of promoting economic growth worldwide and reducing the barriers to global trade

Although many of the specific concerns raised by manufacturers focused on the effect of indirect costs on the supply side of the economic equation, no one disagreed with the notion that the first and most pressing issue was sufficient demand, domestically and globally, to stimulate purchases by consumers and businesses of the goods that U.S. manufacturers produce.

Manufacturers recognized that the most recent recession was one driven by a sharp decline in business investment, rather than a drop in consumer spending. They also understood that policies designed to encourage business investment were essential to any recovery in manufacturing. Most manufacturers indicated that recent efforts to stimulate the economy were paying off, even though they had not fully filtered through to the manufacturing sector. As Mustafa Mohatarem of General Motors put it at the roundtable in Washington, D.C., the recent passage of the Jobs and Growth Tax Relief Reconciliation Act was a "significant achievement," and the resulting recovery in the U.S. economy would "create sufficient or significant demand for investment in the industry" to put the manufacturing sector on the right path.

Despite the reductions in capital gains and dividend taxes, as well as expensing provisions, many manufacturers believed that the recent tax cuts did not go far enough. They underscored the need to create greater certainty under the tax code to encourage business investment. They also emphasized their desire for government to address longer-term issues: specifically, manufacturers highlighted the need to reform the tax code to eliminate the penalties they believe it imposes on their businesses, such as outmoded depreciation schedules and the overall impact of the alternative minimum tax.

They also sought simplification of the tax code, which in its present complexity raises the costs of compliance—particularly for smaller manufacturers. Manufacturers further focused on reforms in the tax code that they believe would yield a broader and deeper pool of investment capital to the benefit of U.S. manufacturers, particularly for small and medium-sized businesses. Murry Gerber, former chair of NAM's Small and Medium Manufacturers Group, explained the need at the New Britain, Conn., roundtable:

They [small and medium-sized manufacturers] haven't kept up to date with new equipment, and you can't blame them. They have had falling sales, their margins are decimated, they don't have the wherewithal. . . . An offer of investment tax credits . . . would drive companies to put on this additional equipment that's consistent with the high-tech manufacturing in the future.

There is little doubt that reducing complexity and making the recent tax

cuts permanent would encourage business investment. Greater certainty as to the tax treatment of earnings is one of the basic components in any firm's investment plans.

The other salient point reflected in the comments of manufacturers was a clear understanding of the implications of slower growth abroad. Roundtable participants focused on the need to use both international monetary and trade policy to promote growth internationally. They cited issues such as exchange rates, based on their understanding of the economics affecting the value of the dollar. They made the point that, in addition to doing everything possible to restore growth at home, the United States needs to press its major trading partners for stronger growth abroad.

Encouraging international economic growth requires consistent advocacy of growth-oriented economic policies abroad. Not only must the United States promote growth through its own economic policies, but it also must be willing to "preach what it practices."

In practical terms for policy-makers, promoting economic growth abroad means action on two fronts. The first is focusing discussions with U.S. trading partners, whether bilaterally or multilaterally, on policies that will foster growth. That means continuing to advocate growth in G7 finance ministers' meetings, the G8 summit, and the annual meetings of the International Monetary Fund and the World Bank, since growth is not an issue for the larger, industrial economies alone. But it also means, most particularly, encouraging the largest economies in the world to pursue policies that stimulate their growth, since they make up a significant share of the world economy.

Growth-oriented economic policies start with the basics, such as promoting respect for private property and observance of the rule of law, which are essential to all market transactions. It means ensuring monetary stability, reducing taxes, and reducing the costs and inflexibility of heavy regulations that impose limits on growth. Every country, including the United States, has room for improvement in terms of the steps it could take to foster growth and a rising standard of living.

Another aspect of growth involves trade liberalization. From the perspective of U.S. manufacturing, reducing trade barriers and opening markets abroad has manifold advantages. Liberalization promotes economic growth in foreign markets, which raises the demand for manufactured goods worldwide. It offers the prospect of higher exports, and the resulting greater efficiencies for American manufacturers and exporters. It also eliminates the implicit subsidy that tariff protection extends to foreign competitors.

Significantly, U.S. manufacturers continue to stand behind the effort to open markets abroad at the negotiating table. That is true of virtually every industry and business large and small. Matthew Coffey, of the National Tooling and Machining Association, which represents many small and medium-sized metalworking firms across the United States, put it this way in an NTMA policy paper:

The NTMA believes in the free-enterprise system . . . whether it is in the United States, the Americas, or the world as a whole. That leads us to the conclusion that competition should be open. The NTMA is in favor of open markets and getting rid of trade barriers and tariffs and has, therefore, generally supported free trade initiatives as long as there was a prospect of fairness over time.[1]

In short, American manufacturers, both large and small, understand the value of promoting economic growth worldwide and reducing the barriers to global trade. They are more than willing to compete in that environment as long as the competition is open and fair, and as long as the same rules governing competition apply equally to all.

Reducing the Costs That Erode Competitiveness

One of the most consistent themes expressed by manufacturers attending the roundtables was the need to "keep our side of the street clean." For manufacturers mean that government, at all levels, must understand that it does not have the luxury of making domestic economic policy choices in a vacuum. Every regulation, every additional form to be filed, every increase in litigation, and every increase in healthcare costs can impose unwarranted costs on American manufacturing.

Manufacturers expressed concern that, too often, fundamental decisions about taxation, government spending, environmental regulation, workplace reforms, energy policy, personal injury compensation, and trade policy are made in isolation. They stated that legislatures, administrative agencies, and courts make decisions without understanding the multiple burdens that those decisions impose on manufacturers.

Rising Healthcare Costs

Curt Magleby of the Ford Motor Company underscored this most frequently cited concern at a roundtable in Washington, D.C.: "Where we really need help for U.S. manufacturing is some stability in healthcare." Most manufacturers indicated that they want to continue to provide healthcare benefits, because such benefits made for a motivated and more productive workforce that contributed to the success of their firms.

Rapidly increasing healthcare costs directly affect the bottom lines of U.S. manufacturers and steadily erode their competitiveness. John Vaught of Tri-Cast noted at the Columbus, Ohio, roundtable that, while the cost of the healthcare he provides to his employees had been "skyrocketing," he was only able to raise prices less than 1 percent a year.

Keith Guggenberger of Starkey Labs summed up the perspective of many U.S. manufacturers, at the roundtable in Minneapolis, Minn.:

Healthcare is a big part of the concerns of policy that we have in keeping us competitive. . . . At Starkey, we spend almost $8,000 per employee on healthcare in the U.S., and when half of our people make under $28,000 a year, it is hard to make those sorts of ends meet.

The problem is becoming particularly acute in the automotive industry, which is central to the health of so many other manufacturers, particularly in the Midwest. At a Washington, D.C., roundtable, Mustafa Mohatarem of General Motors underscored that point:

American companies also face two other challenges that are related to their legacy costs. The first is pensions, which over time is most likely to be equalized. That's something we have negotiated and we're trying to address within that context. The one we don't have as good of control on is the medical side of it. As you know, the cost of medical care has been rising much more rapidly than other costs in our economy. So the traditional American companies that have large healthcare obligations to retirees are being really harmed by this rapid increase in healthcare costs.

This statement is not merely anecdotal: there is no doubt that healthcare costs have risen sharply. A 2002 report by PricewaterhouseCoopers noted that in 2000, the share of U.S. GDP devoted to healthcare was 13.2 percent, up from 8.8 percent in 1980, and, according to forecasts, that share will continue to rise and reach 16 percent of GDP during the next five years.[2]

The rising cost of healthcare is the biggest barrier to health coverage. The annual family health insurance premium increased to $9,068 in spring 2003, according to a survey of 2,808 companies by the Kaiser Family Foundation and the Health Research and Educational Trust.[3] Further,

between spring 2002 and spring 2003, monthly premiums for employer-sponsored health insurance rose 13.9 percent—the third consecutive year of double-digit premium increases and the highest premium increase since 1990. Small firms, with three to nine workers, faced the largest increase of all: a 16.6-percent surge in premiums.[4]

Rising healthcare costs are not unique to the United States. While overall spending on healthcare is higher in the United States, the growth rate of spending is similar to that of other nations. The average real annual rise in healthcare spending in this country was 3.2 percent from 1990 through 2000, which is comparable to the 3.3-percent rate in OECD countries, and the 3.1-percent growth rate among countries in the European Union.[5]

However, what is unique to the United States is the extent to which it relies on businesses as the primary providers of healthcare coverage and the burdens they bear as a consequence.[6] Employer-sponsored health insurance is a cornerstone of healthcare financing in the United States. Three out of every five Americans receive some type of employer-sponsored health benefits.[7]

According to the National Association of Manufacturers, 97 percent of its members continue to voluntarily support employer-provided healthcare in spite of the growing cost of these benefits and the sluggish economy for manufacturing.[8] The percentage of employers providing coverage has not declined substantially, and in spite of rising costs, employers have not increased the percentage of the premium paid by the employee.

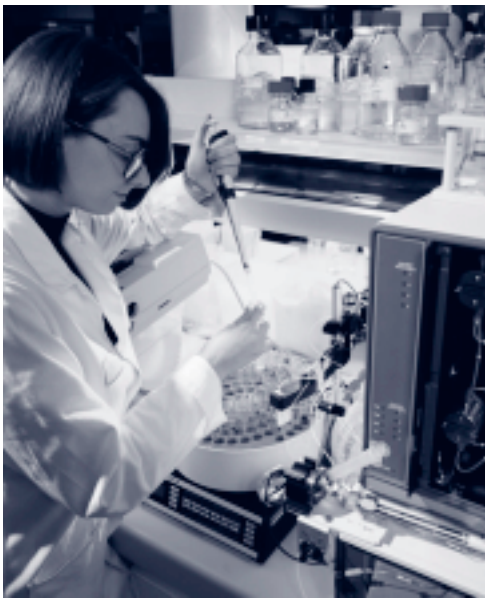
To avoid shifting more of the costs to the actual consumers of healthcare services, employers, particularly those in small and medium-sized manufacturing firms, have to find ways to contain costs or they become less competitive. However, cost containment may not be an avenue open to small manufacturers, which face special problems in obtaining health insurance. They commonly must pay higher premiums and, thus, are less likely to offer health insurance as a benefit.

Employers, both large and small, have responded to these rising costs in a variety of ways. Firms are less likely to offer retiree health coverage; the percentage of large firms offering retiree health benefits has decreased from 66 percent in 1988 to 38 percent today.[9] And many firms increasingly rely on cost sharing as a way to increase awareness of cost and value in healthcare. Tiered reimbursements, often used for drug benefits, have become a common approach to encouraging the use of generic and lower-priced medications. Some companies have begun offering consumer-driven health plans, which combine high-deductible insurance with health spending accounts.

Commerce Secretary Donald Evans, Labor Secretary Elaine Chao, and Treasury Secretary John Snow discuss U.S. manufacturing with factory workers at Harley Davidson headquarters in Milwaukee, Wisconsin.

What these facts suggest regarding policy is that there is economic and competitive value for reducing the growth in healthcare costs that U.S. manufacturing companies face, particularly for the small and medium-sized manufacturers that are the foundation of the U.S. manufacturing

sector. One means of addressing their needs, as well as those of larger firms, would be to encourage the development of association health plans and other joint purchasing arrangements that would increase firms' bargaining power in the market for health insurance and healthcare services.



The historic Medicare reform legislation, which was enacted following the roundtables, provides assistance to firms offering health insurance to retirees and is an important step in controlling healthcare costs. This legislation also established health savings accounts to help employees pay for their healthcare expenses by combining the purchase of a high-deductible health insurance plan with tax-free savings accounts. Employees will use the accounts to pay for their healthcare needs, with any remaining balances rolled over from year to year. HSAs ensure that workers have the health insurance coverage they need plus the money to pay for day-to-day medical care, all while providing them with an incentive to save for their future health care needs.

Addressing the underlying causes of rising healthcare costs would, of course, complement the effort to improve cost containment. In that regard, tort reform, discussed below, is vital. Current malpractice litigation often fails to compensate people who should be compensated and rewards those who do not experience malpractice. In the process, it also dramatically raises the costs of all doctors and healthcare providers, regardless of their records, by increasing liability insurance premiums. Equally important, it raises the cost to the consumer and to the employer in manufacturing by encouraging costly and wasteful "defensive" medicine.

Need for Tort Reform

Perhaps no single issue drew more heated comments from manufacturers than the need for tort reform. Manufacturers pointed to a system that drove insurance costs higher even for firms that had never had lawsuits filed against them or had never put hazardous products on the market. Rick Kelly of Pellerin Milnor Corp. explained at a roundtable in New Orleans, La., that his firm had recently renewed his product liability insurance and was obliged to pay an annual premium worth 30 percent of the coverage itself. As Kelly put it:

We need tort reform real bad. We just recently had our insurance renewed for the following year. A $1-million product liability insurance premium gives you $3 million in coverage. That's insane. That's absolutely insane.

These comments only begin to describe the ways that tort costs debilitate businesses. Manufacturing firms pay "tort taxes" in several ways. First, manufacturers pay significantly higher costs for employee healthcare benefits, due to increasing medical liability costs. Second, manufacturers pay as product liability and other tort claims increase the cost of general liability insurance. And third, manufacturers pay in the form of legal fees even

when there is no merit to claims and manufacturers ultimately prevail in litigation—a problem that is only exacerbated by the growth of frivolous shareholder class-action suits.

The indirect costs of tort litigation are also significant—particularly the time spent by managers and employees, who would otherwise focus on improving operations, raising productivity, and expanding sales. Giff Kriebel of BAE Systems put that part of the tort system in perspective at the roundtable in Manchester, N.H. He said, "I can think of nothing that is more non-value-added than all the litigations that all of us have to go through. . . . The time it takes and distraction that it causes is absolutely huge."

The basic reason for manufacturers' concern about the civil liability system is the dramatic increase in tort claims and awards. Manufacturers have become outsized targets, as plaintiffs' lawyers consider operating companies' "deep pockets" of insurance and capital. From a personal injury lawyer's perspective, manufacturers represent desirable defendants because juries can more easily sympathize with a claimant by assigning blame to a seemingly impersonal corporation regardless of fault, assumption of risk by the plaintiff, or contributory negligence.

The tort system significantly undermines the competitiveness of U.S. manufacturers. The awards have driven insurance premiums higher and, in instances when liability insurance proved cost prohibitive, the insurance premiums have driven firms out of business.

The examples of tort claims cited by manufacturers attending the Commerce Department's roundtables were striking. In many instances, the connection between the plaintiff's injury and the product put on the market by the defendant manufacturer was dubious or nonexistent. From these types of tort claims, it is difficult to reach any conclusion other than that the company in question was targeted simply because the plaintiff's counsel identified it as the deep pocket from which the lawyer could maximize the award.

Consumers, workers, and investors all pay for excessive claims of the current tort system. Tort costs amount to a tax on consumption, wages, and investment. Clearly, tort costs make U.S. manufacturers less competitive, increase the risk of bankruptcy, and are a significant drag on the American economy.

Just as important is the fact that the current system also fails to deliver for those who are injured and deserve compensation. Only 20 percent of direct tort costs actually go to claimants for economic damages, such as lost wages or medical expenses.[10]

the basic reason for manufacturers' concern about the civil liability system is the dramatic increase in tort claims and awards

The U.S. tort liability system is already the most expensive in the world; its cost is more than double the average cost of such systems in other industrial nations, as measured in GDP share. The consulting firm of Tillinghast-Towers Perrin published findings that in 2002, the U.S. tort system cost $223 billion—approximately 2 percent of the nation's GDP.[11] Similarly, the U.S. Chamber of Commerce recently released a study showing that a state's tort liability system has a "statistically significant" impact on its economic development, which in plain terms means slower economic growth and fewer jobs, particularly in manufacturing.[12]

It is crucial to understand that none of these studies capture anything more than the direct outlays of existing firms, such as the payment of liability insurance premiums. Although those costs continue to rise dramatically, they understate the impact on manufacturers and the cost to

the U.S. economy as a whole. These studies do not capture the value of the products that otherwise would have been developed or other opportunities that manufacturers have forgone because of litigation risk.

Manufacturers stated that commonsense legal reforms are crucial to bolstering manufacturing competitiveness. Although tort liability is most often a function of the common law of each state, a better balance needs to be struck. In fact, individual states are already developing models of tort reform in an effort to maintain their manufacturing bases.

Wisconsin's efforts at reform were touted at the Commerce Department's roundtable in Milwaukee as one of the reasons for manufacturing firms staying despite higher taxes and relatively broad regulation. As explained at the roundtable, the reforms in Wisconsin did no more than restore some of the balance that previously existed in U.S. tort law, as opposed to the strict liability standards enacted in many jurisdictions.

One particular issue on the legal front dwarfed all others: the ongoing asbestos litigation, which continues to create a great deal of uncertainty for manufacturers in the marketplace. The point raised by many manufacturers was hard to dispute. When asbestos was first installed as a safety device to retard the spread of fire in many factories, no one knew the potential danger of long-term exposure to asbestos. The product was not subject to regulation by the government, nor was there any warning to manufacturers regarding the risks inherent in its use.

But now, many years later, the multiple class-action lawsuits filed over the use of asbestos have created a legal and financial quagmire. While the litigation continues, affected individuals in American society are not receiving any assistance to cope with the medical bills they face. And the continuing litigation remains a cloud over the entire manufacturing sector.

The comments of Dow Chemical's Gene Reinhardt at a New Jersey roundtable put the problem in context:

Asbestos litigation that continues after so many years . . . is a problem for society in that . . . the victims of asbestos are not the ones getting the help. We'd like to see that we get some legislation that would protect the victims now and in the future and make the system fair. It is chaos now, with litigation coming from all directions that is damaging the economy and undermining the security of jobs and pension systems.

Tort reform should focus on three areas. The first is the critical need to cap medical malpractice awards in ways that ensure that those deserving compensation get compensated. The second is the need to restore the balance that previously existed in tort law: meaningful reforms are required that would hold individuals accountable for their own actions in the use of products, rather than holding manufacturers strictly liable for any injury suffered in proximity to their products. And the third area is the need to resolve the litigation over asbestos-related injuries by ensuring that those deserving compensation receive it. Such class-action suits remain a contingent liability for U.S. manufacturers, making it hard to attract capital and liability insurance for their current operations.

Reducing Regulatory Costs

At the roundtables, manufacturers frequently mentioned the issue of regulatory costs and the relative burdens they place on U.S. firms versus their competitors. An OMB study found that regulatory costs were 3.7 percent of GDP in 1997.[13]

Since manufacturing tends to bear a greater share of regulatory costs than other sectors, it is safe to assume that roughly 4 percent of manufacturing GDP goes to compliance. Of this, about half of

the cost is for compliance with environmental regulations; the remainder is for compliance with workplace safety and product safety requirements, as well as for the time spent filling out government paperwork and keeping records.

One measure of the economic cost of compliance is the cost to government of managing regulatory programs and the consequent drain on tax revenues which that effort represents. Total federal budget outlays for regulatory compliance activities have almost doubled in the past 13 years, from $13.7 billion in 1990 to $26.9 billion in 2003 in real terms.[14] Those costs cover all regulatory activities, from trade and customs, to consumer safety, to securities laws. They do not include the cost to the private sector of compliance, which can be many times greater.

From a manufacturer's perspective, particularly that of a small or medium-sized business, the most common compliance costs are related to environmental regulation, workplace safety, and tax compliance/employment rules. The Small Business Administration's Office of Advocacy has conducted the most comprehensive study of those costs.[15] The study found that the total cost of complying with regulations in those areas in 1997 amounted to $147 billion annually, or a cost per employee of $7,904. Of the individual categories that made up that total, environmental compliance costs took the largest share. Environmental costs accounted for nearly 50 percent of the total: $69 billion in 1997, or a cost per employee of $3,691.[16]

Significantly, the cost of compliance with such rules falls hardest on businesses with fewer than 20 employees. According to the SBA study, small manufacturing businesses reported that compliance with workplace rules amounted to a cost of $16,920 per employee. For larger firms, that cost dropped by more than half, to $7,454 per employee.[17]

Further, taken together, all compliance costs appear to have increased significantly since the SBA's study of 1997 data. According to a recent NAM study, the total burden of environmental, economic, workplace, and tax compliance is $160 billion on manufacturers alone, equivalent to a 12-percent excise tax on manufacturing production. This reflects an increase of about 15 percent over the last five years.[18] In short, regulatory compliance costs are rising faster than income in the manufacturing sector, which implies a loss of cost competitiveness or, at a minimum, a negative offset to the benefits of the extraordinary productivity gains and efforts by manufacturers to cut costs under their direct control.

Rising Energy Costs

Another point of concern for manufacurers is the rising cost of energy, particularly natural gas. Manufacturers depend on affordable, reliable energy. Industry uses more than one-third of all the energy consumed in the United States, the majority of which is natural gas and petroleum, followed by electricity. In all sectors, energy prices have a significant effect on operations and product prices.

Manufacturers uniformly criticized the failure to enact the legislative aspects of a comprehensive and coherent energy plan that would increase America's energy independence while yielding energy prices that would help ensure manufacturers' long-term competitiveness. Don Wainwright of Wainwright Industries put it in straightforward terms at a roundtable in St. Louis, Mo., explaining that manufacturing is "one of the biggest users of energy." He emphasized that, in his view, the biggest challenge facing his industry is "energy policy, which is before the Senate right now."

As it stands, America "faces the most serious energy shortage since the oil embargoes of the 1970s," directly attributable

to a "fundamental imbalance between supply and demand."[19] From 1991 to 2000, Americans consumed 17 percent more energy than they had in the previous 10 years. During that same period, U.S. production rose only 4.9 percent; the difference accounted for by imports.[20]

America's energy challenge will continue to grow as the U.S. economy grows. Energy consumption in the United States is expected to rise "by about 32 percent by 2020."[21] While the Bush administration has pursued successful executive actions to increase domestic access and production, there is no prospect, in the absence of congressional action, for significant new U.S. production.

Conservation and efficiency can help, and U.S. manufacturers lead the way in producing and implementing technologies designed to foster efficiency and reduce costs. Those efforts pay big dividends. Today, it takes only 56 percent of the energy required to produce a dollar of GDP as it did in 1970. The nation's "energy intensity" (the amount of energy required to produce a dollar of GDP) has declined in recent years and is expected to decline further, at a rate of 1.5 percent yearly, through 2020.[22] With appropriate capital investments, conservation could reduce that figure even further. Yet in the short run, rising energy prices and disruptions in energy supply reduce profits, production, investment, and employment for U.S. businesses. In practical terms, absorbing the cost of high and rising energy prices means deteriorating profit margins. And by reducing a manufacturing company's cash flow, high energy costs restrict a firm's access to capital needed for new plants and equipment.

rising energy prices and disruptions in energy supply reduce profits, production, investment, and employment for U.S. businesses

The impact of high energy costs on the demand side also negatively affects manufacturers. With rising energy costs taking a greater percentage of consumers' budgets, consumer spending slows, lowering demand for manufactured goods. That contraction in demand feeds back into the manufacturing sector in the form of lower sales, lower use of capacity, and an inability to take advantage of the economies of scale that manufacturers' existing capital investments would otherwise afford.

For energy-intensive industries such as paper products, plastics, and chemicals, the impact of rising energy costs, particularly the cost of natural gas, is compounded. At the Commerce Department's roundtable in Trenton, N.J., Gene Reinhardt, of Dow Chemical Company, explained:

Those of us in the chemical sector are getting a double hit with natural gas, since we use it both for our fuel and as raw material for our chemicals. . . . Natural gas prices are the highest in the world and drain all of the industry. Consumers are spending $70 billion more in natural gas costs in 2003 than they did last year in 2002. So it is not only an emergency or an emergent issue for Dow Chemical; it is really an issue for all of the industry in America.

Additionally, energy supply disruptions can pose a significant problem even in industries in which energy is not an important component of the total cost of the goods or services produced. Many businesses require a high-quality, reliable source of power. Even a brief loss of power can impose significant costs on technology firms. Products or product inputs may be damaged or destroyed, or production runs may be interrupted.

The effects of the blackouts in California several years ago illustrate this. A survey of small businesses, which was conducted by the National Federation of Independent Business in February 2001, found that more than half of the firms surveyed that had experienced blackouts in California were forced to reduce or shut down business operations altogether during the blackouts. About one-third of the firms surveyed lost sales. Roughly one-fifth

said materials were aged or destroyed. And nearly two-fifths absorbed additional costs, such as in wages and benefits, for work that was not completed.[23]

Plainly, the problems manufacturers face because of rising energy costs and disruption have been a long time in the making. They are the product, like many of the other issues manufacturers raised during the roundtables, of nearly a decade of neglect. To put it in perspective, it helps to understand that not a "single major oil refinery has been built in the United States in nearly a generation." By some estimates, the United States needs "38,000 miles of new gas pipelines, along with 250,000 miles of distribution lines" to match the demand for natural gas with supply.[24]

It will take a comprehensive, long-term strategy to address the energy challenges facing America's manufacturing sector, and an equal attention to modernizing the U.S. energy infrastructure, increasing energy supplies, and improving energy conservation and efficiency. And it will require a multifaceted approach. The nature of the problem requires first that government ensure that energy markets work well; for example, by moving ahead with the restructuring of electricity markets where necessary to ensure that energy savings are passed on to the consumer. The problem may also merit a hard look at increased federal funding for research and development of renewable energy resources and energy-saving manufacturing techniques and products, tax incentives for the development of new technologies, and greater coordination among the various levels of government involved in the approval and development of new energy supplies and infrastructure.

Taxes

Manufacturers pointed to federal, state, and local taxes as one of the key factors inhibiting future investment in American manufacturing. Manufacturers attending the roundtables stressed the importance of cutting taxes in a way that would stimulate consumer demand and business investment, which has lagged even during the recovery from the recent recession.

The other frequently made point is the need for certainty. What manufacturers attending the roundtables see in the marketplace is an unwillingness of their

customers to make the investments that will lead to purchases of capital equipment and a strong recovery throughout the manufacturing sector. That unwillingness is inconsistent with the strong consumer demand that continues to pull the economy along through the recession and into a stronger recovery.

Manufacturers explained that the other forces inhibiting investment are related to the general uncertainty regarding the strength of the recovery, concerns regarding the effect of the events of September 11, 2001, the rising cost of security in their aftermath, and to the more uncertain international economic environment. However, the one concern manufacturers identified that is entirely within the control of

the federal government is the uncertainty created by frequent changes in the tax code and the often-conflicting policies that the tax code represents. U.S. manufacturers put a premium on getting the right rules and rates in place and then making them permanent so businesses can invest with greater certainty in terms of the treatment of income earned on their investments.

Interestingly, the most salient but least-understood tax issue involves the international provisions of the Internal Revenue Code. Far from encouraging companies to move offshore, manufacturers believe the IRC contains significant penalties on income derived from foreign investment that sometimes lead to the double taxation of foreign-source income. In a global economy, manufacturers understand that their successes will increasingly depend on their ability either to export (which often requires investment abroad in marketing) or to sell to U.S. firms that compete in global markets (which also increasingly depends on the ability to invest, produce, source, and sell abroad). In short, manufacturers recognize that the government should not impose penalties on those American companies that are the best U.S. competitors in world markets, even when the exact penalties imposed by the Internal Revenue Code are not always apparent to purely domestic producers.

manufacturers attending the roundtables stressed the importance of cutting taxes in a way that would stimulate consumer demand and business investment

The basic point in support of tax reform was made by Curt Magleby of Ford Motor Company at a roundtable in Washington, D.C.:

Our tax code internationally was developed in the 1940s and 1950s [and] updated in the 1980s and represented a completely different environment. For us to be competitive domestically, we've got to update the tax code on the international side.

In addition to the IRC's outdated international provisions, manufacturers identified numerous ways in which the code may distort investment decisions. They cited the alternative minimum tax, which imposes significant extra costs on manufacturers and results in almost no additional revenue for the federal government. In addition, depreciation schedules in some sectors may not reflect high rates of innovation.

Assessing the full impact of the investment distortions contained in the current IRC requires an understanding of how the IRC's impact reaches well beyond the federal system of taxation. Because many state tax codes are ultimately based on definitions of income that flow from the federal tax code, the distortions of the IRC perpetuate themselves at the state level.

Several manufacturers went considerably further with respect to state and local taxation, suggesting changes to the most prevalent forms of state and local taxation. Many states and localities rely more heavily than the federal government on property and other taxes that are fixed in dollar amounts or in the form of a fixed percentage of asset value. Those taxes become far more regressive in an economic downturn; although revenues and income fall, the liability for tax does not. The net effect is an increase in tax on manufacturing firms as a percentage of income. The manufacturers' comments suggested a need to shift from taxes based on fixed values to those tied to income, and to rely more heavily on consumption as the basis for defining income subject to taxation.

Lastly, with respect to taxes, there is broad recognition of the advantage conferred on foreign manufacturers by the interrelationship between the current U.S. tax system and international trade rules. American manufacturers are well aware that most of their competitors are located in countries that rely more heavily on consumption, rather than income, as the basis for taxation. In practical terms, foreign governments apply taxes solely to income

earned on sales in their jurisdictions and will rebate any taxes that apply to exports.

By relying more heavily on income as the basis for taxation, and in taxing U.S. manufacturers on their worldwide income, the U.S. system contains no simple means of ensuring that U.S. exporters receive comparable treatment. The international trade rules reinforce that disparity because they allow the rebate of indirect taxes (that is, taxes on consumption such as value-added taxes) but prohibit the rebate of any direct taxes on income, on which the U.S. system relies so heavily. Although manufacturers believe recently passed changes in federal tax law have helped, manufacturers maintained that those changes do not go far enough to offset the underlying inequity between the tax treatment of most foreign manufactured goods and those produced in the United States.

The basic lesson to draw from the roundtables regarding tax is the need for both short- and long-term efforts to reduce the cost and uncertainty that the IRC creates for American manufacturers in their operations and their pursuit of investment capital needed to maintain their competitiveness. In the short term, the most significant step would be to make the recent tax cuts permanent in order to increase the certainty of the business environment in which manufacturers operate and the relative attractiveness of investing in manufacturing in the United States. In the long run, manufacturers called for an intense focus on tax reform—reform that reduces rates, reduces investment distortions, and simplifies the IRC to reduce the cost of compliance.

Reinforcing America's Technological Leadership

At every roundtable, American manufacturers expressed their concern for America's contined leadership in technology and its ability to produce the workforce needed to maintain U.S. excellence in manufacturing. Manufacturers continually emphasized the important role that technology plays in serving customers and ensuring cost competitiveness. Lou Auletta of Bauer, Inc., made that point at the New Britain, Conn., roundtable:

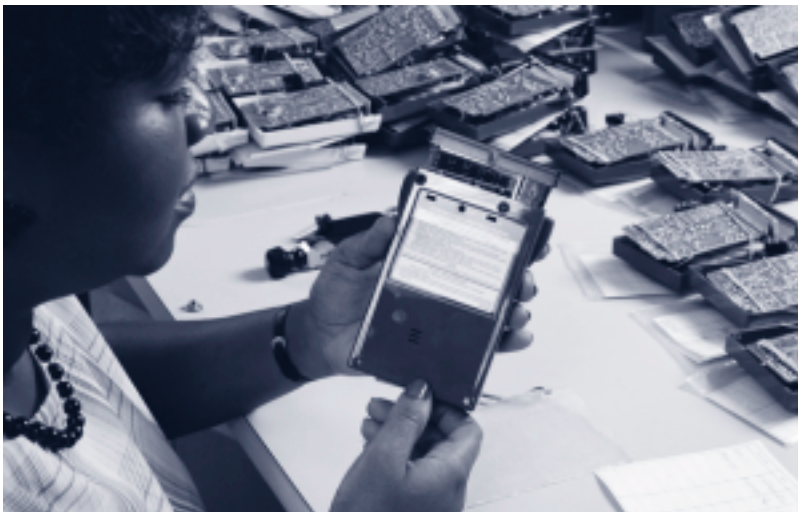
We're in the process of developing new technologies that are going to save our customers money, and also technologies and enhancements that are going to make us more efficient in production, both from the design aspect and the manufacturing side.

Manufacturers understand that leadership in innovation and technology are key to their future competitiveness. William Fee of Magnesium Elektron, Inc., at the Trenton, N.J., roundtable spoke for many in describing the process that his company had gone through to remain competitive, and the extent to which it increasingly depends on investment in technology:

Our response has been to shift our business towards more technically sophisticated applications, for example, catalysts, high-tech ceramics, and water treatment. To achieve competitive advantage in these new markets, we corner a strong commitment to research and development and ongoing innovation in products and the processes needed to manufacture them. To be successful, this strategy requires significant investment in scientific talent, laboratories and analytical equipment, intellectual property patents, and following the pursuit of same information technology to control manufacturing processes, and even the most difficult of all is step change in the level of detail engineering support necessary to manufacture products to ever-tightening specifications and consistency demanded by our customers.

From the perspective of manufacturers, there is a need for continuing investment in research and development of new products so that manufacturers remain one step ahead of the competition.

The fact that technology and innovation are key to the future of manufacturing simply reinforced the concern many manufacturers had for the declining investment in research and development as a percentage of GDP, both in industry and in government. Mike Mauer of Sikorsky Aircraft Group made that point at the roundtable in New Britain, Conn., noting that U.S. manufacturing's competitive edge depends on "great new technology . . . that's a result of some of the investments that were made 20, 30 years ago." Mauer described the decline in investment in research and development as "worrisome," recognizing that future



competitiveness is "really about the technology and the investment up front and . . . the engineering and development that ends up leading" manufacturing toward a more competitive future.

Many of the comments focused on making the Internal Revenue Code's research and experimentation credit permanent. At the roundtable in New Britain, Conn., Murry Gerber, former chair of NAM's Small and Medium Manufacturers Group, stated what was a uniform opinion among manufacturers:

One is the R&D tax credit, which should be made permanent. We've been arguing about this for years and years, and it's critically important because if you want to know where manufacturing is going to be in 20 years; it's going to be involved with the highest-tech work that's possible in the world that can't be done in other nations where they pay 80 cents a day or whatever to lesser skilled workers.

As noted at the outset, U.S. manufacturers continue to invest in innovation and technology, accounting for the majority of R&D dollars spent in any given year. The roundtable participants also emphasized the importance of government's investment in the basic sciences that lead to later innovations in manufacturing. They view government's role as catalytic—sparking many of the ideas that manufacturers later transform into consumer products.

Manufacturers expressed concern over the declining commitment of federal government funds for directed basic or generic technology research of the sort that drives innovation in manufacturing. At the Washington, D.C., roundtable focused on the future of manufacturing, many of the attendees highlighted the well-known role that the Defense Department and the National Aeronautics and Space Administration played in research on electronics, computing, and communications. What manufacturers seek is focus within the government's budget on research that would yield the same spillover effects that the earlier work on defense applications and the space program provided.

U.S. manufacturers suggest that the federal government's ability to provide the means necessary to maintain the technological edge of the United States needs to be strengthened. At the roundtable in Minneapolis, Minn., which focused on manufacturers in the medical device industry, many of the participants commented on the need to improve the responsiveness of the Food and Drug Administration to the requirements of a rapidly evolving indus-

try. Currently, the FDA is grappling with the question of how best to regulate the introduction of biotechnology into the marketplace. In the view of some manufacturers, the inability to match the speed of innovation in industry with innovation in government is becoming a drag on what provides the United States its primary advantage in the manufacturing sector—continuing innovation.

Education and Skills

The President's Council of Advisors on Science and Technology (PCAST) recently completed the first phase of a study gauging the health of U.S. high-tech industries. The PCAST report emphasizes a concern that motivated many of the participants in the Commerce Department's roundtables: with continued outsourcing of manufacturing functions to lower-cost alternatives outside the United States, the United States risked losing the "innovation infrastructure of design, research and development, and the creation of new products and industries."[25]

George Scalise, president of the Semiconductor Industry Association and chairman of the PCAST subcommittee that drafted the report, put it this way:

Foreign governments—and especially China—have done an effective job of creating a rich environment for the manufacture of electronics and semiconductors, and the implications are that U.S. high-tech leadership is not guaranteed. That is all there is to it. We have it. We enjoy it. We have been here forever, but it is not guaranteed going forward. If we lose that leadership and if we don't have that as a driving force in our economy, it will have an impact on our ability to maintain and further improve our standard of living in the future. That is a reality.[26]

The numbers bear out that other countries are increasing their technological sophistication. The United States, until recently, consumed 40 percent of the world's semiconductor production, meaning that American firms were manufacturing goods containing 40 percent of the world's semiconductors. In the past two years, the U.S. share has dropped to 20 percent, whereas Asia now represents 40 percent of the world's semiconductor consumption.[27]

One of the principal advantages Asia now holds is a very well-educated technical workforce. Both China and India are graduating high numbers of talented scientists and engineers. In 2002 alone, 58 percent of all the degrees awarded in China were in engineering and the physical sciences, compared with 17 percent in the United States. China's 219,600 engineering graduates accounted for 39 percent of all college graduates, whereas U.S. engineering graduates, a total of only 59,500 engineers, represented a mere 5 percent of all college graduates in the United States.[28]

Particularly troubling is that comparative advantage in today's manufacturing sector has less to do with physical endowments, such as natural resources, than it has to do with human capital. According to some U.S. firms' estimates, by 2010, as much as 90 percent of their research and development, design, and manufacturing will be conducted in either China or India. There is frankly little government can do through tax, cost reduction, and other policies to prevent this shift toward Asia if the United States is not at the same time providing the talent pool necessary to continue spurring innovation.

The discussions of education, training, and workforce needs in manufacturing at the Commerce Department's roundtables raised the same concerns. Beyond the incentives needed for investment in research and development, manufacturers stressed the importance of a skilled workforce in maintaining America's technological leadership. Chris Bollinger of Bollinger Shipyards, Inc., at the roundtable in New

Orleans, La., identified the "biggest problem that we see" as the "lack of qualified labor." He indicated that this observation was true even during the recent recession. He expressed concern about what that meant as the manufacturing sector recovered, calling the lack of qualified labor "our biggest issue and our biggest . . . roadblock to continuing to grow."

From the perspective of most manufacturers, the effort to maintain America's leadership in innovation and technology must begin with improvements in the basic education delivered by U.S. public schools. Many manufacturers now spend a considerable amount of time and resources simply training their workers to meet the basic skill levels that workers in other countries have attained by the time they enter the workforce.

General Motor's Mustafa Mohatarem identified the problem at a Washington, D.C., roundtable, noting, "the auto industry was always considered a high-wage industry that would hire people without much education. Your physical skills were much more important than your mental skills. That clearly has changed." To meet the challenge that this change presents will require continuing improvement in the basic education America gives all students through high school.

Most manufacturers recognize, however, that even a solid high school-level education is not enough to remain relevant in today's manufacturing sector. Tim Timken of the Timken Company made that point at a roundtable held in Washington, D.C., concerning the future of manufacturing. He emphasized that his company, the world's leading manufacturer of roller bearings, was increasingly looking for workers who had training beyond high school, up to and including four years of college, for entry into the company's workforce. The reason for that shift is the increasingly complex capital equipment involved in today's manufacturing processes.

Manufacturers stressed the need to concentrate increasingly on readying students for the requirements of modern manufacturing and the modern marketplace. They emphasized the potential threat to U.S. technological leadership from declining numbers of engineering graduates and high school graduates with adequate technical skills to qualify for even entry-level jobs in manufacturing today.

Phyllis Eisen of the National Association of Manufacturers captured the views of many when, at a Washington, D.C., roundtable, she offered the following perspective:

We are in a highly competitive state with other countries that have taken education very seriously for a very, very long time—from small countries like Denmark, [which] have been at the peak of pushing kids in the educational world, to China, [which] graduated close to 40 percent of engineers as undergraduates last year. We graduated less than 6 percent. Now this should be a frightening thought to all of us. Manufacturing is an engineering-based industry, and whether we're training technicians at a very high scale or high performance production workers or engineers and chemists or whatever . . . we're not doing it fast enough or good enough, and we have to put as much pressure on the education community and ourselves to work with them.

The role of talent is critical to the future viability of America's manufacturing sector. The 2001 *U.S. Competitiveness Report,* published by the Council on Competitiveness and co-authored by Professor Michael Porter, stated that "the priorities for sustaining U.S. economic growth and competitiveness center on strengthening the nation's innovative capacity and skills of the American workforce."[29] The report further stated that "the nation's ability to commercialize innovation—and further productivity growth—rests on the skills of its workers. But, the bar for skills is rising-and demand for higher skills is outstrip-

ping supply."[30] Higher-level skills are essential to enable productivity and commercialize innovation.

Worker skills and education will be a dominant, if not decisive, factor in America's ability to compete in the global economy. The United States' ability to engage in the world economy must be accompanied by a commitment to boost the skills of every worker. Educational institutions must respond by giving every American the tools to prosper in the global economy.

The final component that manufacturers focused on in their comments about workforce needs and training was the need to ensure lifelong learning. Nowhere is that need more acute than in the case of workers faced with a layoff because of changes in the underlying economics of their industry.

Traditional trade adjustment assistance programs, though helpful in those specific instances, may not actually address the circumstances faced by most workers laid off during the recent recession who have yet to be called back to work simply because the manufacturer has learned to produce the same quantity of output with fewer workers. That drive to innovate and raise productivity may or may not be spurred by competition from imports, but that debate is increasingly irrelevant in light of the changes under way in the manufacturing sector. There are a number of federal as well as state programs directed at training and retraining workers. The Workforce Investment Act, passed in 1998, has gone a long way toward streamlining and consolidating the efforts of a wide variety of federal job-training initiatives. However, more change is needed to make the system more responsive in a dynamic and rapidly changing economic environment. As a part of that effort, it would also be helpful to work toward programs that actually encourage re-employment. It is widely understood that the most valuable training and retraining occur on the job. Being out of work, even briefly, means that an individual's skills are eroding. Programs that put a premium on helping individuals find new employment may be the most important form of adjustment assistance.

Communities and Economic Development

A separate topic is the adjustment of communities. Recent stories of plant closures in the hard-hit textile mill towns throughout the Southeast reinforce the need to ensure closer linkages between community economic-development initiatives and workforce development programs. As a practical matter, job training programs are useful only if there are jobs available for those pursuing the training.

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Consistent with the need to upgrade the skills of existing and dislocated workers is the need to ensure that there is a diversified economy capable of employing those workers. Areas with diversified economies are more stable and generally provide for a higher standard of living for their citizens. Communities that are overly dependent on a single industry are at greater risk for economic dislocation.

There is considerable room for communities to engage in thoughtful and proactive economic-development planning. Establishing a comprehensive strategic plan for economic development is a critical element in maintaining a community that can grow, thrive, and endure changes in the economic environment. Coordinated economic development programs can help build a more favorable business climate to attract private investment.

Economic development planning is, furthermore, not just a strategy for adjustment in a particular industry. A sound ap-

proach to economic development can help promote competitiveness, innovation, and increased productivity among existing businesses or industries in the community as well.

One of the development concepts manufacturers highlighted is the concept of clustering. Economically healthy regions can often foster competitiveness and innovation by focusing on industry clusters—groups of interrelated firms and industries. America's ability to produce high-value products and services that support higher-skill and higher-wage jobs largely depends on the creation and strengthening of these competitive clusters. Significantly, the concept of clusters both draws on and reinforces the benefits of funding for research universities, which often form the core of such clusters.

In general, there is a need for a more aggressive look at how existing economic development programs could best reinforce a community's development of a sound approach to building a more diversified and strengthened local economy. Reinforcing the focus of communities on building more diversified economic bases is one means of both attracting and retaining manufacturing companies.

Leveling the International Playing Field

Perhaps the key short-term demand of U.S. manufacturers is for a level international playing field. They stressed the importance of international economic policies, on both finance and trade, which ensure that U.S. manufacturers have a fair opportunity to compete.

Disparities in the Cost of Doing Business

According to manufacturers attending the roundtables, one key reason for leveling the international playing field is to address the differences in the cost of doing business within the United States to the costs of doing business in other countries. Steve Prout of Alpha Q at the New Britain, Conn., roundtable cited the earlier discussed issue of rising healthcare cost as contributing significantly to increased indirect costs that affect competition. "Many of our companies have seen medical healthcare cost increases of 20 percent or greater. You cannot sustain that year after year . . . it's just impossible."

Those and other cost differences confront U.S. manufacturers with stark choices and create an incentive to shift manufacturing abroad. As Joe Fusco, of Novus Fine Chemicals, put it at the roundtable in Summit, N.J., "I could throw up my hands. I could shut my factory. I could turn my factory into condominiums . . . and then just ship my manufacturing overseas, and—guess what—I can make . . . more money."

What Fusco added was also representative of most American manufacturers. While acknowledging the differences in costs that are driving many manufacturers offshore, Fusco also stressed:

I don't think that that's the right way to go. That's just my opinion. I'd like to think that we can be creative and innovative. . . . It's really about just . . . doing a good job and being productive and [competitive]. And we do . . . But the only thing I'm complaining about is this uneven playing field that I see.

Economic and Trade Policy and Manufacturing Interests

Roundtable participants raised the issue of exchange rates, in particular China's peg of its currency, the yuan, to the dollar. Many manufacturers expressed concern that exchange rates with a number of trading partners are set by government intervention rather than market forces, leading to lower U.S. exports and stronger import competition. American manufacturers pressed for the market to set the terms of competition, not governments.

Manufacturers attending the roundtables made the same basic point about trade. What most manufacturers asked for was not for protection from international competition, but to level the playing field by lowering trade barriers abroad. As Jay Jackson of Stuller, Inc., a privately held jewelry manufacturer and wholesaler, pointed out at the New Orleans roundtable:

Mexico went to zero percent [tariffs] on precious jewelry in January of 2002. And first quarter of this year, we actually had an 8 percent-plus balance of trade surplus of greater exports going to Mexico than were actually imported, and that's the first time. So we can compete if we're allowed to compete where we have the competitive edge, and we can compete with the low labor cost, but we just have to have that level playing field.

There were serious criticisms of U.S. trade policy. Some manufacturers expressed continuing concerns about the impact of trade agreements, such as NAFTA, and questioned whether continued U.S. participation in the World Trade Organization is warranted.

Other criticisms reflected dissatisfaction with the terms of the agreements themselves, particularly the extent to which they opened the U.S. market to goods made with low-cost labor. Those criticisms were offset, to an extent, by the recognition that, in today's manufacturing, direct labor costs in the form of wages actually represent a small portion of the total cost for most manufacturers, with certain exceptions such as apparel manufacturers.

Further, most manufacturers argued that the global marketplace is here to stay and that the United States is better off using the tools available to ensure that competition in that global marketplace is on even terms. For most, it was clear that one of those tools is trade negotiations, and many applauded the U.S. initiative within the WTO to eliminate tariffs altogether as the most direct route to ending the current disparity.

Stephen Collins of the Automotive Trade Policy Council, which represents U.S. automakers on international trade issues, echoed that basic point at a roundtable in Washington, D.C.:

The greatest levels of growth are going to be outside of the United States. That's where the U.S. government does have an extremely important role in helping to open those markets through the WTO, through bilateral negotiations, and through regional negotiations. And the reason it's so important is because those governments will try to protect their markets and try to protect the development of their markets during that same period.

That basic point is worth underscoring. Manufacturers understand that tariff protection abroad is not only a barrier to its exports, but it also represents a means of subsidizing foreign manufacturers by limiting the competition they face. In fact, the disparity in tariff rates applied by foreign countries compared with the tariffs applied on goods entering the United States was, apart from the difference in operating costs, the most common example that U.S. manufacturers pointed to in terms of the lack of a level playing field.

many manufacturers expressed concern that exchange rates are set by government intervention rather than market forces

Kimberly Hayden of Supreme Tool & Die at the roundtable in St. Louis, Mo., expressed her strong dismay at the disparities in tariff rates, stating what many others voiced at roundtables across the country:

In 2020, if things don't change, we may not be here. That playing field needs to be evened out in order for us to compete globally. I can compete in the United States. I can't compete with the Chinese imports, and I can't import or export my product over there. . . . Bringing a die cast tool into the United States, the total

taxes equal 3.9 percent. Bringing a die cast tool from the U.S. into China, the taxes equal 30 percent.

Tariffs are not the only trade barrier that U.S. manufacturers face. Another salient example is the lack of adequate intellectual property protection and enforcement in the markets of some of America's major trading partners. For U.S. manufacturers, protection of intellectual property is not an abstract concept. America's competitive edge ensues directly from innovation and rising productivity. Intellectual property protection is the best means for ensuring that American manufacturers enjoy the benefits of their investments in research and development and of their efforts to raise productivity. It is also the means best calculated to ensure that they can enjoy the investment they make in customer service and creating a brand name that distinguishes them from other manufacturers.

As Frank Johnson of the Manufacturing Alliance of Connecticut underscored at the New Britain, Conn., roundtable:

We understand what free trade was designed to be, but free trade isn't free. We want free trade. If there is a tariff on tea going into China and not coming into the United States, that's not fair. If a manufacturer in China can steal pictures from a Connecticut manufacturer's advertising brochure and put them on their Web site and use the company's trademark name to sell products in China, that's not fair. We want fair trade. We understand free trade, but we want it to be fair. We want to level the playing field in every place that we can. We want the Chinese and other competitors to honor trademark laws. We want them to respect . . . to show the same respect to U.S. manufacturers that we show to them.

Indeed, U.S. manufacturers indicated a willingness to compete in a global market, but they want to make sure that the ground rules are the same for everyone and that those ground rules are enforced.

Toward this end, the administration has undertaken a number of significant initiatives to address this issue: an increased focus on intellectual property rights enforcement, heightened efforts to promote the adoption of U.S.-developed technical standards, focused efforts on enforcement and compliance, particularly with respect to China, and expanded export promotion activities.

The rapid globalization of world markets presents American manufacturers with new challenges and opportunities. Falling trade barriers create opportunities in two forms. First, lower barriers to trade open markets for American exports. The United States is already one of the most open economies in the world.[31] Lowering barriers to trade largely means lowering barriers to trade abroad, where significant barriers still exist.

Second, increased trade brings stronger competition, which represents a double-edged sword for U.S. manufacturers. Although it can place stiff demands on U.S. manufacturers, competition in trade also ensures that American manufacturers remain competitive. Increased competition demands higher productivity, greater efficiency, and greater innovation. In today's global economy, the industries that engage in the constant process of innovation—lowering costs, creating new products, and serving new markets—represent market leaders.

Global competition represents an opportunity for American manufacturers in one other respect as well. Opening markets abroad allows U.S. manufacturers to take advantage of economies of scale that they would not enjoy if they were limited to the U.S. market alone. It also delivers high-quality, low-cost inputs that are necessary to maintain the competitiveness of American manufacturing in many sectors.

In many industries, particularly those in which American manufacturers main-

tain a significant technological or other competitive advantage, there is growth in exports. During the roundtables in Chicago and Minneapolis, several firms indicated that more than 50 percent of their sales are now offshore. That trend holds true for firms throughout the high-technology sector of the American economy.

Most of the manufacturers with whom Commerce Department officials met understand the benefits of trade and indicated that much of what they produce is destined for foreign markets. However, some manufacturers believe that the federal government is not aggressive in defending the interests of American manufacturing in its international economic and trade policy. They argued that the broad opening of U.S. markets through NAFTA was evidence that federal government officials did care about U.S. manufacturing or its competitiveness.

Instead of the terms of the deal, critics of NAFTA focus on Mexico's subsequent devaluation of the peso, which had a far more significant impact on the terms of trade between Mexico and the United States than did cuts in tariffs or quotas. That fact is reflected in the movement of U.S. trade with Mexico from surplus to deficit in the years immediately following the implementation of the agreement.

The lesson many in manufacturing drew from that experience is that the U.S. government, following the implementation of the trade agreement, failed even to acknowledge the implications for American manufacturing of the agreement and the subsequent peso devaluation. The balance of payments adjustment assistance provided to Mexico after the peso devaluation simply reinforced that impression.

In fact, NAFTA has proved to be a boon economically to all parties by making the U.S., Canadian, and Mexican economies more efficient. Indeed, most critics ignore the actual terms of the agreement under which Mexico had to undertake far more significant reforms and was obliged to remove more trade barriers than Canada or the United States, simply because the U.S. and Canadian markets were already largely open to Mexican products.

Even the most ardent critics of U.S. trade policy, however, were not advocating protection from import competition, nor were they looking for subsidies. Rather, they were looking for a level playing field—an equal opportunity to compete for business both at home and abroad.

Manufacturers showed support for an aggressive trade policy intent on opening markets. Such a policy does not require backing away from current trade negotiations in the WTO or in bilateral, multilateral, or regional free trade agreements. It does, however, require that the interests of American manufacturers, as well as U.S. farmers and service providers, be served by those negotiations and that the U.S. government be vigilant in ensuring that the benefits of the bargains reached at negotiating tables are, in fact, delivered.

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It also requires an understanding that trade policy does not take place in a vacuum. During the latter part of the 1990s, trade policy was in a rut because of a debate about the extent to which future trade negotiations should be conditioned on labor or environmental standards. That debate prevented the previous administration from vigorously pursuing, much less obtaining, trade negotiating authority. The debate was also one of the many reasons that the WTO conference in Seattle in 1999 failed to launch a new round of multilateral trade talks.

From U.S. manufacturers' perspective, the politics of the trade debate largely ignore the need for an ongoing effort, without the threat of coercion, to improve

labor and environmental standards. There is little doubt that there is much to be gained by encouraging economic growth in the developing world. As countries develop, they tend to choose higher labor and environmental standards for themselves. Trade liberalization is one of the most promising means by which to achieve those higher standards.

Concerns Regarding the Trade Deficit

Many manufacturers point to the trade deficit, including the rising bilateral trade deficit with China, as a major concern. While the trade deficit has changed little over the past year and exports have been rising, America's trade and current account deficits reflect broad economic forces, strong U.S. growth relative to growth in America's major trading partners, and a low-inflation environment. Sustained, strong U.S. performance relative to performance abroad has also served to attract substantial capital to the United States to finance the current account deficits. At the most fundamental level, the current account deficit is related to developments in U.S. national saving relative to U.S. investment. When investment is higher in the United States than domestic saving, foreign investors make up the difference, and the United States has a current account deficit. Increased private saving and deficit reduction in the United States will work to reduce the current account deficit.

growth in the trade deficit has been driven by relative rates of economic growth and consumption, rather than the competitiveness of American goods and services

The Bush administration's international economic strategy aims for high economic growth throughout the world. At the core of this strategy are the growth-oriented economic policies being implemented within the United States. But working with U.S. trading partners to encourage pro-growth and pro-stability policies is also a central part of the administration's strategy. Good economic policies in other countries benefit the United States and the rest of the world. It is widely recognized that free markets are best able to allocate scarce resources to their most productive uses. The United States believes that the goals of raising growth and increasing stability can best be accomplished in an international financial system that relies on the principles of free trade, free capital flows, and market-based exchange rates among the world's major economies.

The world economy has strengthened over the past year. Outside the United States, growth in Japan has resumed, and prospects for the euro area brightened in the second half of 2003. The United Kingdom and Canada, as well as many emerging market countries, are also growing more strongly. Rising U.S. exports reflect this greater vitality in America's trading partners.

However, what the broader trend of weak export performance should not obscure is the fact that certain industries have faced, and continue to face, a surge in imports that, in particular sectors, has a stronger impact than the decline in exports. Textiles and apparel are primary examples. The most significant feature shaping those sectors has been the gradual removal of quotas on textile and apparel products that have protected the two sectors since the textile agreements of the early 1960s. Quotas had the effect of maintaining a relatively high level of investment and productive capacity, as well as supporting higher price levels. They also allowed for the existence of sectors characterized by a large number of firms producing a wide variety of products. In addition, they provided an incentive for the establishment of outward processing arrangements to try to maintain industry competitiveness.

As quotas were removed pursuant to the Uruguay round of GATT negotiations,

increased competition lowered prices, dampened profitability, and placed much of the previous investment in apparel under pressure from competition from abroad. In response, apparel manufacturing, which is labor intensive, began to move offshore. Meanwhile, U.S. textile manufacturing, which encompasses increasingly capital-intensive enterprises, began to see its primary customers move offshore or enter bankruptcy. The resulting decline in demand for U.S. textile production has placed the fabric makers in the same difficult financial position that apparel makers faced earlier.

The rise in the trade deficit does not necessarily indicate that American manufacturing is uncompetitive. As mentioned above, growth in the trade deficit has been driven by relative rates of economic growth and consumption, rather than the competitiveness of American goods and services. Many American manufacturers see the playing field being distorted by foreign government intervention.

Most discussions of trade begin and end with a survey of the most recent round of trade talks and what they mean for particular sectors of the U.S. economy. In the past 15 years, a dynamic has unfolded that has complemented and reinforced the impact of trade negotiations in lowering the barriers to trade worldwide as well as the opportunities and challenges lower barriers create for American manufacturers.

U.S. leadership within the context of post-World War II international economic institutions was an important component of the overall effort to ensure the future of freedom, democracy, and a market-based economic system in the midst of the Cold War. Unilateral trade liberalization toward the developing world formed an essential element of American foreign assistance strategy, which was also a tool in achieving broader foreign policy goals. In the long run, however, multilateral trade liberalization by both developing and developed countries would provide the greatest overall benefit.

But some manufacturers expressed concern that the United States has "given more than it has gotten" out of the world trading system and that foreign policy, rather than U.S. commercial interests, drives trade policy. Those views are based on the visible difference between the average tariffs in the United States and those in many markets abroad and on the obvious point that the United States has proved willing to open its market faster than the vast majority of its trading partners. Although the broader reach of U.S. foreign policy certainly was one of the motivating reasons for pursuing trade liberalization, it is difficult to point to a specific area where, as a result of foreign policy concerns, American negotiators put more on the table than they otherwise would have done. The argument also tends to ignore the active role that Congress has played in oversight of the trade negotiation process in defense of particular manufacturing industries' interests. That oversight alone has ensured that trade policy has normally been driven by commercial considerations.

It is also worth reiterating what those views ignore: the benefits of an open trading environment and the competition it brings. There is little doubt that open economies grow faster than closed economies and that competition is essential. The United States itself has, because of its openness, grown considerably faster than it otherwise would have.

Notes:

[1] Matthew B. Coffey, "NTMA Manufacturing Policy" (paper adopted by NTMA Executive Team, July, 16, 2003).

[2] PricewaterhouseCoopers, "The Factors Feeding Rising Healthcare Costs" (April 2002).

[3] Kaiser Family Foundation and the Health Research Educational Trust, *Employer Health Benefits; 2003 Annual Survey* (Washington, D.C.: Kaiser Family Foundation, 2003).

[4] Ibid.

[5] Alliance for Health Reform, *Covering Health Issues: A Sourcebook for Journalists* (Washington, D.C.: Alliance for Health Reform, 2003).

[6] That is not to say that the total cost of healthcare does not take a toll on manufacturers elsewhere. Even in systems like Canada's or Great Britain's, where the government actually provides the healthcare, taxpayers, including manufacturing companies, end up paying for it in the form of higher taxes. To the extent that those taxes take the form of value added or similar taxes that are rebated upon export of a manufactured good, the price of the good on international markets may not fully bear the cost of the healthcare system in a way that U.S. goods must, since they are built into the cost base of the U.S. manufacturer itself.

[7] National Association of Manufacturers, *Health Care Costs at the Crossroads: Manufacturers' Agenda for Lower Costs and Higher Quality* (Washington, D.C.: The Manufacturing Institute, 2002).

[8] Ibid.

[9] Kaiser Family Foundation, Employer *Health Benefits 2003*.

[10] Jeremy A. Leonard, *How Structural Costs Imposed on U.S. Manufacturers Harm Workers and Threaten Competitiveness* (Washington, D.C.: National Association of Manufacturers, 2003).

[11] Tillinghast-Towers Perrin, *U.S. Tort Costs: 2003 Update; Trends and Findings on the Costs of the U.S. Tort System* (New York: Tillinghast-Towers Perin, 2003).

[12] Todd Buchholz and Robert Hahn, *Does a State's Legal Framework Affect Its Economy?* (Washington, D.C.: U.S. Chamber of Commerce Institute for Legal Reform, 2002).

[13] Office of Management and Budget, Office of Information and Regulatory Affairs, *Report to Congress on the Costs and Benefits of Federal Regulations* (Washington, D.C.: Office of Management and Budget, September 1997).

[14] Leonard, *Structural Costs*.

[15] Thomas Hopkins and W. Mark Crain, *The Impact of Regulatory Costs on Small Firms*, report no. PB2001–107067 (Washington, D.C.: U.S. Small Business Administration, Office of Advocacy, 2001).

[16] Ibid.

[17] Ibid.

[18] Leonard, *Structural Costs*.

[19] National Energy Policy Development Group, *Reliable, Affordable, and Environmentally Sound Energy for America's Future* (Washington, D.C.: National Energy Policy Development Group, May, 2001).

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] National Federation of Independent Business, "NFIB Poll Reveals Initial Effects of Deregulation on California Small Businesses" (press release, Feb. 26, 2001).

[24] National Energy Policy Development Group, *Energy for America's Future*.

[25] President's Council of Advisors on Science and Technology, "Report on Information Technology Manufacturing and Competitiveness" as reported in *Manufacturing and Technology News* (Oct. 3, 2003).

[26] Ibid.

[27] Ibid.

[28] Ibid.

[29] Michael E. Porter and Debra van Opstal., *U.S. Competitiveness 2001: Strengths, Vulnerabilities and Long-Term Priorities* (Washington, D.C.: Council on Competitiveness, 2001), p. 37.

[30] Ibid.

[31] On a trade-weighted basis, the U.S. average tariff is less than 1.7 percent; the current U.S. simple average tariff is 3.6 percent on a legally bound basis under the WTO. Average tariffs throughout much of the world are significantly higher, with simple average WTO legally bound rates of 31.4 percent in Brazil, 37.2 percent in Egypt, 49.8 percent in India, and 39.5 percent for WTO members overall. The manufacturing sector of the U.S. economy is also largely free of non-tariff barriers to trade, such as quotas and trade-distorting subsidies. In addition, because of requirements of the Commerce Clause of the Constitution, there are few barriers to trade within the United States. Taken together, that makes the United States the most open and contestable market of any major economy in the world.

Three

Recommendations and Next Steps

The recommendations that follow are designed to address the challenges identified by U.S. manufacturers over the course of the Commerce Department's roundtable discussions. These recommendations represent a step toward building the comprehensive strategy called for by Secretary Evans to ensure "that the government is doing all it can to create the conditions" that would enhance U.S economic growth and manufacturing competitiveness.

These recommendations start from the premise that it is manufacturers and their actions in the marketplace that will define their success, spur economic growth, and create jobs. The government's role is not to interfere with that process, but rather to foster it. For government, creating the conditions for success in the marketplace means focusing on economic fundamentals, such as encouraging economic growth and innovation in the private sector and reducing the cost of government policies on U.S. manufacturers. It also means regulating only when absolutely necessary and then with a view toward minimizing unwarranted costs.

This same basic approach informs the recommendations on international economic policy and trade. The recommendations are designed to encourage governments to open markets and eliminate trade practices that distort markets for goods, capital, and labor. They are also designed to foster compliance with the rules governing the international trading system so that it is competition in the marketplace, rather than government intervention, that determines success.

The recommendations include proposals that demand immediate action by Congress and new activities that can be pursued under existing authority to strengthen current efforts to support U.S. manufacturers. A number of recommendations also provide direction for broad-based reforms that will require coordinated effort over the long term. The new Assistant Secretary of Commerce, called for by President Bush in his September 4, 2003, Labor Day address, will be responsible for coordinating the administration's efforts to implement these recommendations.

The recommendations are divided into the following six sections:

- Enhancing Government's Focus on Manufacturing Competitiveness
- Creating the Conditions for Economic Growth and Manufacturing Investment
- Lowering the Cost of Manufacturing in the United States
- Investing in Innovation
- Strengthening Education, Retraining, and Economic Diversification
- Promoting Open Markets and a Level Playing Field

Enhancing Government's Focus on Manufacturing Competitiveness

One of the major concerns registered by manufacturers was the long-standing lack of focus and accountability within government on manufacturing and its competitiveness. The following recommendations are intended to sharpen that focus and to ensure accountability for implementing the recommendations that make up the Manufacturing Initiative.

Beyond providing greater focus and accountability, the recommendations are also designed to enhance coordination within the federal government and with state and local authorities to improve the domestic economic environment for manufacturing. These steps would establish a mechanism for ongoing dialogue with the manufacturing sector on the implementation of the President's Manufacturing Initiative.

These activities would further the work begun by this report. One of the first steps that the newly established assistant secretary should take is to conduct a study of the cost competitiveness of U.S. manufacturing relative to its principal competitors. This should include an assessment of the business environment in terms of supporting innovation, not just in terms of products and services, but in manufacturing process and business organization. This work will help determine whether there are additional steps the government could take to reduce costs and to enhance competitiveness.

Create an Assistant Secretary of Commerce for Manufacturing and Services

As President Bush called for in his Labor Day address, the federal government should establish an assistant secretary-level position at the Department of Commerce to serve as the principal point of contact with the U.S. manufacturing sector. The assistant secretary would be responsible for implementing the recommendations contained in this report and for supporting the Secretary of Commerce in his role as the federal government's chief advocate for the manufacturing sector.

Specific responsibilities of the assistant secretary would include:

Lead a Benchmark Analysis to Measure Progress toward Achieving the President's Goals

One of the key components of any strategy is a means of measuring progress toward a defined goal. That requires both a baseline that sets a starting point for analysis and the tools to measure progress. To establish a baseline against which to measure progress toward improving the economic environment for manufacturing in the United States, the newly established assistant secretary would work with the Council of Economic Advisers, the U.S. Treasury and Labor Departments, and other relevant agencies, to initiate a benchmark analysis of the U.S. environment for manufacturing.

The study would identify and prioritize those areas of public policy that have the most impact on manufacturing competitiveness. The findings should be subject to further analysis to determine what, if any, actions could be taken. In addition, the study would review initiatives to improve manufacturing competitiveness underway at the state and local level or abroad.

Create a New Office of Industry Analysis

Through a new Office of Industry Analysis, the assistant secretary would be responsible for assessing the cost competitiveness of American industry and evaluating the impact of domestic and international economic policy on U.S. competitiveness, particularly in the manufacturing sector. This effort would require developing the analytical tools and expertise within the Commerce Department

to assess the impact of proposed rules and regulations on economic growth and job creation before they are put into effect.

Establish a President's Manufacturing Council to Provide Oversight and Advice on the Implementation of the President's Manufacturing Initiative

To ensure that the government responds to the challenges facing U.S. manufacturers and remains focused on what matters to their competitiveness, Congress should establish a Manufacturing Council under the chairmanship of the Secretary of Commerce. The assistant secretary would serve as the executive director of the council. The council would provide a means of ensuring both regular contact between government and the manufacturing sector and effective counsel in the implementation of the President's Manufacturing Initiative. The council's membership should reflect the diversity of American manufacturing in terms of industries and the size of the enterprise, particularly small and medium-sized businesses.

Create an Interagency Working Group on Manufacturing Chaired by the Secretary of Commerce

Implementing the recommendations outlined below will require coordination among a number of agencies within the federal government. Toward that end, the administration should establish an interagency working group modeled on the Trade Promotion Coordinating Committee. This manufacturing competitiveness interagency working group, chaired by the Secretary of Commerce, would be responsible for coordinating the implementation of the recommendations, as well as developing new initiatives that would carry President Bush's Manufacturing Initiative forward.

Foster Coordination and Cooperation among Federal, State, and Local Governments

Not all of the steps needed to foster an economic environment helpful to manufacturing reside in the jurisdiction of the federal government. However, the federal government could serve as a coordinator of activities designed to foster a healthy manufacturing sector throughout the United States. The states have traditionally served as laboratories for a wide variety of initiatives that have shaped economic policy throughout the country. The administration should create an intergovernmental coordinating committee on manufacturing, with the assistant secretary serving as the coordinator, to ensure that sound ideas on regulatory reform or economic development strategies are widely available to all state and local governments.

Creating the Conditions for Economic Growth and Manufacturing Investment

Creating an economic environment designed to foster manufacturing competitiveness begins with establishing the conditions for strong economic growth at home. Congress has already taken several significant steps toward that goal by enacting President Bush's proposals reflected in the Economic Growth and Tax Relief Reconciliation Act of 2001, the Job Creation and Worker Assistance Act of 2002, and the Jobs and Growth Tax Relief Reconciliation Act of 2003.

By acting decisively to lower the tax burden on American manufacturers, particularly for small and medium-sized businesses, President Bush and Congress helped to keep the recession short and start the process of economic recovery. According to the U.S. Treasury Department, had President Bush and Congress failed to enact those measures, by the end of 2004, 3 million fewer jobs would have been created and a deeper recession and a far slower and more uncertain recovery would have resulted.

Nevertheless, there remains an enormous amount that government can still do to increase the certainty of the business environment in which U.S. manufacturers operate. The following steps would ensure that the government makes progress toward that goal.

Make Recent Tax Cuts Permanent to Enable Manufacturers to Attract Capital and Invest for the Future with Confidence

One of the key features of the recent recession was the sharp drop in business investment. Consumer spending, which makes up two-thirds of U.S. GDP, remained strong throughout both the recession and the subsequent recovery. Business investment, which accounts for the other one-third of GDP, has gained strength but has yet to reach pre-recession levels.

Fostering a climate for strong business investment, particularly in manufacturing, requires a stable economic environment that reduces risk. Reducing risk requires greater certainty. Congress should increase certainty and foster a healthier climate for investment in manufacturing and other sectors of the economy by making the recent tax cuts permanent.

The elimination of the estate or "death" tax, the temporary increase in expensing limits, and the new incentives for small business investment are among the most significant business-related features of the recent tax cuts. In addition, the reductions in individual marginal tax rates aid those businesspeople whose incomes flow through directly to individual returns, such as sole proprietors and partnership members. Congress should act to make the elimination of the death tax and the investment incentives for small businesses permanent to ensure that manufacturers, particularly small and medium-sized businesses, are able to attract the investment capital needed to ensure their future competitiveness.

Reduce the Costs of Tax Complexity and Compliance

U.S. tax laws have become unnecessarily complex. Complexity increases the cost of compliance and creates a drag on the economy, with businesses spending more time and resources on compliance and diverting talent and resources away from productive activities. Small business owners are particularly unprepared to deal with this complexity and do not have the resources to hire sophisticated tax counsel to advise them. It is time to make a serious effort to simplify the tax rules. The Treasury Department should undertake a study of tax simplification, focusing on those provisions that are particularly complex for manufacturers, including

depreciation, the corporate alternative minimum tax, and the research and experimentation tax credit.

Make Permanent the Research and Experimentation Tax Credit

While public investment in research and development is a critical component in the development of new technologies, the private sector bears the burden of the research and development needed to bring those technologies to market.

To reinforce the existing incentive available under the Internal Revenue Code, Congress should make the research and experimentation (R&E) tax credit permanent.[1] Making the R&E credit permanent has been a consistent, long-time priority for advanced manufacturers. Doing so will increase the certainty associated with the tax treatment of research expenditures and thereby reduce the risk and cost associated with attracting or allocating capital expenditures to such activities.

Deepen the Pool of Investment Capital Available to Manufacturers by Introducing Incentives for Saving

Another key element for encouraging investment is deepening the pool of investment capital available to U.S. business. To do so, Congress should adopt tax incentives to increase the savings rate of American taxpayers.

Increasing U.S. savings and investment would also address the growing U.S. trade deficit. By providing incentives for savings and investment, the United States would reverse one of the main causes of the trade deficit, as well as expand access to, and lower the cost of, capital available to U.S. manufacturers.

Lowering the Cost of Manufacturing in the United States

As manufacturers made clear in every roundtable discussion, to make the United States an attractive place to invest in manufacturing, government must reduce the costs it imposes on manufacturers. The following recommendations outline steps that the government should immediately take to bring down the cost of manufacturing in the United States, including regulatory, energy, legal, healthcare, and pension costs.

Reduce the Cost and Improve the Availability of Healthcare

Healthcare costs represent the largest and fastest rising costs faced by U.S. manufacturers. These costs are also least within their control to manage. Manufacturers have a vested interest in the health of their employees. Building on the historic Medicare reforms signed into law by President Bush, the following actions would help reduce the burden of providing this care:

Establish Association Health Plans

As President Bush has endorsed, Congress should pass legislation to create and fund association health plans. Such plans would afford small business manufacturers greater leverage in negotiating the cost of health insurance with providers. That leverage would translate into lower healthcare costs and improved cost competitiveness.

Promote Health Savings Accounts

Health savings accounts (HSAs) were established in the Medicare prescription drug bill signed by the President on December 8, 2003. HSAs combine high-deductible health insurance plans with tax-free savings accounts that can be used to pay for medical expenses incurred by employees and their families. Under HSAs,

year-end balances can be rolled over, encouraging employees to be more cost-conscious and giving them both an incentive and the means to save for future healthcare needs.

Accelerate the Food and Drug Administration's Review of New and Generic Drugs

In addition to the FDA's broad efforts to speed the development of safe, innovative, and low-cost new health treatments, the FDA continues to expedite the review of generic drugs in order to make lower-cost prescription drugs available to consumers. The administration has increased funding for generic drug reviews by over 35 percent over the past two years, allowing the FDA to establish ambitious new performance targets for reducing review times for generic drugs. Continued FDA performance improvements will allow new and generic drugs to reach the market more quickly, resulting in lower prices for prescription drugs available under employer health plans.

Implement New Technologies to Prevent Costly Medical Errors

To ensure medical treatments are being used as effectively as possible and to prevent costly adverse events, the healthcare industry should adopt and implement 21st century technologies such as bar coding of medical products and electronic prescribing.

Enact Medical Liability Reform

Congress should enact legislation making the medical liability system fair, predictable, and timely. Reforms should include the adoption of standards that ensure that injured patients are compensated fully and quickly for their economic losses, while limiting recoveries for non-economic damages to a reasonable amount.

Taken together, these steps would significantly reduce the current burden that high healthcare costs impose on U.S. manufacturers, particularly those small and medium-sized businesses that make up the bulk of the U.S. manufacturing sector.

Modernize the U.S. Legal System to Eliminate Disincentives to Invest in Manufacturing

The U.S. legal system discourages investment in manufacturing by raising the risk and cost associated with manufacturing. There are three steps Congress should immediately take to lift the disincentives for investment in manufacturing that the current system of tort liability creates:

Enact Class-Action Reform

Congress should enact a common sense class-action system through the passage of a consumer "class-action bill of rights" that would, among other provisions, require notice of a lawsuit to class members in understandable terms, require judicial review of settlements that give class members only non-cash benefits, and prohibit a court from approving a settlement that discriminates among plaintiffs.

Enact Asbestos Reform

Litigation is an enormously expensive means of compensating those injured by the use of asbestos in construction prior to the 1970s. Because asbestos is no longer being used in construction, class-action lawsuits no longer serve even a deterrent purpose. Congress should enact legislation resolving the current class-action litigation on asbestos. The asbestos litigation continues to dampen investment in manufacturing. Passage of legislation that will ensure compensation for those actually injured and stop litigation that destroys jobs is critically important.

Make the Medical Liability System Fair, Predictable, and Timely

The most significant step government should take to improve the medical liability system and reduce its costs to U.S.

manufacturers would be to adopt standards that ensure injured patients are compensated fully and quickly for their economic losses, while limiting recoveries for non-economic damages to a reasonable amount.

In addition, the administration and Congress should undertake a long-term effort to ensure an appropriate balance in the tort system between plaintiffs' and defendants' interests. As questions of tort liability are frequently adjudicated at the state level, any such effort would ultimately require close cooperation with the states to ensure the best approach and a higher degree of consistency.

Reduce the Costs of Regulation and Legislation

The cost of regulation on the U.S. economy has been the subject of ongoing reviews since the late 1970s. OMB reviews of proposed regulations, and statutes such as the Paperwork Reduction Act, have contributed to that effort. In addition, the Bush administration has slowed the increase in regulatory costs produced by new regulations reviewed by OMB by 70 percent compared with the previous administration.

Nonetheless, overall, the cost of regulatory compliance has risen significantly over time. To combat these rising costs, OMB should lead a comprehensive three-step process to reduce the burden of regulation on manufacturing enterprises:

Establish an Inventory of Potential Regulatory Reforms that Would Lower the Cost of Manufacturing

To establish an inventory of potential reforms that would reduce the cost of compliance on the manufacturing sector, OMB should seek public comment on existing rules and afford the opportunity to propose particular reforms. The request for public comment and the nomination of reforms should address existing regulations, guidance documents, and paperwork requirements.

Conduct an Analysis of the Inventory

OMB should, in coordination with the Council of Economic Advisers, the Commerce Department, and other agencies, evaluate the proposed reforms and, where appropriate, implement those reforms on a priority basis. This evaluation should include an assessment of the cost of compliance and the economic impact of current rules, particularly on small and medium-sized businesses, as well as the cost to the taxpayer and to the consumer of administering those regulations. The objective of the review should be to determine whether there might be a less costly means of achieving the benefits Congress intended by authorizing such regulations. That analysis should extend to the agencies that implement the rules as well. This effort could involve broadening the analysis done under section 610 of the Regulatory Flexibility Act, which currently applies to small businesses.

Conduct a Regulatory Impact Analysis of New Rules

Lastly, OMB should rigorously apply its recently developed guidance on regulatory impact analysis to any proposed rules that would influence the costs imposed on the manufacturing sector, particularly as they affect small and medium-sized businesses. As a part of this effort, the newly established assistant secretary for manufacturing and services should task the new Office of Industry Analysis to work with OMB and other agencies to refine the analytical tools needed to assess the impact of proposed rules and regulations on economic growth and job creation in the manufacturing sector and other areas of the economy.

Enact a Comprehensive Energy Plan That Encourages Conservation, Improves Infrastructure, and Expands Domestic Production

According to the National Association of Manufacturers, about one-third of the United States' energy, including 40 percent of the natural gas and 30 percent of the electricity, is consumed by manufacturers. Energy shortages, price spikes, and blackouts disrupt the economy; discourage investment in energy-dependent manufacturing industries, such as chemicals and plastics; and inhibit manufacturers in those sectors from planning with confidence and hiring new workers.

Given the significant increase in U.S. energy costs, enacting a comprehensive plan to encourage conservation, improve infrastructure, and expand domestic production is fundamental to the future of American manufacturing. Adopting a comprehensive energy plan, particularly one that addresses the need for expanded natural gas production and distribution, would help reduce the cost in some manufacturing sectors considerably. Such action would offer a particular benefit to those manufacturing industries, such as plastics, that depend on natural gas both as a source of power and as an input into their manufactured goods.

President Bush has proposed a comprehensive national energy policy that would, if enacted by Congress, modernize and expand our electricity infrastructure, modernize and increase conservation and energy efficiency, ensure a clean and affordable diversity of fuels for producing electricity, increase domestic energy supplies, and increase the development and deployment of new technology.

In short, Congress should pass President Bush's energy plan to reduce the cost of energy to U.S. manufacturers. From the perspective of U.S. manufacturers, the most important steps that President Bush has proposed and on which Congress should act are:

Increase Electricity Supply and Modernize the Legal Framework Governing Electricity Production

Congress should modernize the legal framework governing electricity production and transmission to lessen the chance of disruptive blackouts and ensure the delivery of ample and affordable supplies of electricity. The provisions should establish mandatory and enforceable reliability standards, encourage expanded investment in transmission and generation facilities, eliminate transmission bottlenecks, reform outdated laws, promote open access to the transmission grid, promote regional planning and coordination, protect customers, and help develop new technologies.

Facilitate Adequate and Economical Supplies of Natural Gas

Congress should facilitate adequate and economical supplies of natural gas by eliminating the regulatory obstacles to the development of natural gas resources on federal land and to the construction of liquefied natural gas terminals and other infrastructure, simplify the permit process and facilitate the construction of an economically viable natural gas pipeline from Alaska, and encourage additional deep-well gas development on the outer continental shelf.

A Clean and Affordable Diversity of Fuels for Electricity Production

Congress should moderate future demand growth for natural gas by ensuring a future for clean-burning coal and nuclear power, and providing tax incentives to increase the production of electricity from renewable sources such as wind, solar, biomass, and landfill gas.

New Technology

Congress should encourage further research and development in new energy technology, particularly the funding of President Bush's hydrogen fuel initiative to develop technology for commercially viable hydrogen-powered fuel cells and a new generation of hydrogen powered vehicles to help reduce U.S. dependence on foreign oil.

Promote Pension Reform

The administration will work with Congress to make fundamental changes in the funding rules that will put underfunded plans on a predictable, steady path to better funding. Improvements in the funding rules should set stronger funding targets, foster more consistent contributions, mitigate volatility, and increase flexibility for companies to fund up their plans in good economic times. The administration will continue to work with Congress and the private sector to address this issue.

Investing in Innovation

The discussion above and the views of manufacturers highlight the need to bolster further the development of new technologies that fuel productivity gains and improve U.S. security and the U.S. standard of living. The following recommendations are designed to ensure that the United States remains the most competitive and productive economy in the world.

Review Federal R&D Funding for Generic Technologies, Engineering, and the Physical Sciences to Encourage Better Coordination and Focus on Innovation and Productivity-Enhancing Technologies

Since taking office, President Bush has provided a renewed focus on federal research and development funding. For fiscal year 2004, he proposed a record $123 billion, which represented an increase of more than 34 percent over funding levels that existed when he took office.

Continuing this effort to enhance government funding of research and development activities is crucial to the continued U.S. success in manufacturing.

Also needed is a review of current federal R&D programs important to manufacturing, to ensure that there is an appropriate focus on innovation and productivity-enhancing technologies. The Commerce Department's Technology Administration, in coordination with the Assistant Secretary for Manufacturing and Services should conduct this review with other affected agencies, through the National Science and Technology Council's Interagency Working Group on Manufacturing R&D, and the private sector.

The review should consider the need for additional investment in core R&D programs for generic technologies, engineering, and the physical sciences, especially in interdisciplinary scientific endeavors. The model followed should be

the same one that has been used over the past 50 years to develop the major technologies influencing the U.S. economy today (semiconductors, computers, network communications, biotechnology, and now nanotechnology). This model is based on government funding of basic science and early-phase generic technology research, followed by massive investment in applied R&D by the private sector.

Identify Priorities for Future Federal Support for Advanced Manufacturing Technology—Create an Interagency Working Group on Manufacturing Research and Development

To improve the effectiveness of federal investment in manufacturing research and development, a new interagency working group should be established within the National Science and Technology Council. This interagency working group would serve as a forum for developing consensus and resolving issues associated with manufacturing R&D policy, programs, and budget guidance and direction.

The working group should identify and integrate requirements, conduct joint program planning, and develop joint strategies for the manufacturing R&D programs conducted by the federal government. Among the responsibilities of this group would be to review all federal manufacturing R&D programs and establish priorities designed to improve U.S. manufacturing technology.

The review would be aimed at identifying the timely and critical early-stage developments needed to provide a fundamental foundation for industrial research and development and the commercialization of related applications. The review would be comprehensive, covering a wide breadth of manufacturing innovation technologies, such as supply chain integration, interoperability technologies, measurements and standards, and manufacturing information technologies. It would also address the need for new industry-university-government research dedicated to high-priority manufacturing R&D needs, knowledge diffusion, and education of the next generation of manufacturing technologists and leaders.

Strengthen the U.S. Patent and Trademark Office

Patents have always been key to rewarding manufacturing innovations, but their importance has been magnified by the fact that the application of new technology has become one of the key ingredients in successfully competing in manufacturing globally. Delay in the issuance of a patent can mean the difference between success and failure in today's marketplace.

The USPTO currently runs the risk of seeing its processing times erode. The administration has proposed legislation that would significantly enhance the ability of the USPTO to meet the needs of U.S. manufacturers. Congress should pass this legislation to ensure that the USPTO can continue to serve the needs of manufacturers by protecting their intellectual property and increasing the availability of new products and services in the marketplace.

Strengthen Partnerships to Promote Manufacturing Technology Transfer

Robust research and development activities are essential steps in reinforcing the process that has provided U.S. manufacturing with its competitive edge. These activities, however, should be matched with an equally vigorous effort to ensure that the technology developed is diffused broadly throughout the manufacturing sector, particularly to small and medium-sized manufacturers, which will benefit most because of their own limited capacity for independent research and development.

The PCAST report on technology transfer of federally funded R&D, released in May 2003, provides 10 recommendations for strengthening technology transfer.[2] These recommendations will provide valuable insight for strengthening technology transfer to the manufacturing community.

Implementing these recommendations will require a comprehensive effort, led by the National Institute of Standards and Technology. As a part of that effort, NIST should take the lead in identifying and promulgating best practices in intellectual property management, cooperative R&D agreements, and partnering arrangements needed to enhance the benefits and delineate the obligations associated with such cooperative efforts. Participation from existing groups such as the Federal Laboratory Consortium, the Interagency Working Group on Technology Transfer, and others should be solicited in this comprehensive effort.

Expand Cooperative Technical Assistance Programs on Standards

In an increasingly globalized economy, the capacity to compete successfully will depend on the ability of individual manufacturers to satisfy global as well as U.S. standards. Most U.S. manufacturers understand the importance of achieving these goals and have invested heavily in satisfying not only product standards, but quality and environmental standards as well.

The importance of standards in manufacturing will only increase with the demands placed on manufacturers hoping to compete for a place in global supply chains. Indeed, in many respects, international standards will define access to the global marketplace. To ensure that standards with a potential to affect the access of U.S. manufacturers to markets around the world are set objectively, based on sound science, NIST should expand the reach of programs designed to provide technical assistance to standards agencies, national metrology institutes, and regional metrology organizations in the developing world, particularly in significant potential export markets.

Ensure the Reliability of the Critical Infrastructure That Is Vital to Manufacturers

The United States' most advanced manufacturing industries and the infrastructures that they depend on—power, communications, and transportation in particular—are increasingly dependent on sophisticated, distributed automated control systems. Typical of these are the control systems that manage the electric power grid; similar systems control the production and distribution in critical infrastructure industries such as oil and gas, water, chemicals, pharmaceuticals, metals and mining, pulp and paper, and durable goods manufacturing. Protecting these critical control infrastructures from failure, either by accident or by malicious intent, is essential to the long-term security of the manufacturing sector—and the nation as a whole. Therefore, the following steps should be taken:

Promote Standards to Better Protect Industrial Control Systems

The federal government should work vigorously and hand-in-hand with the private sector and state and local agencies to encourage and enable standards development organizations in the United States to establish needed security standards for industrial control systems.

Support the Research and Development that Underpins Critical Infrastructures—and Quickly Transfer the Results of That R&D to the Private Sector

As part of the administration's emphasis on improving homeland security, the federal government today is providing

dramatically expanded support for the research and development that is necessary to protect the nation's critical infrastructures that U.S. manufacturers and the U.S. economy and society at large depend upon so heavily. In addition, the administration should ensure that the manufacturers and users of industrial control systems are involved with—and are kept informed about—the latest research advances from the Department of Homeland Security, the Commerce Department, and elsewhere.

Support a Newly Coordinated Manufacturing Extension Partnership and Create a National Virtual Network of Centers of Manufacturing Excellence

Since its inception as a pilot program in 1988,[3] the Manufacturing Extension Partnership (MEP) has provided many small U.S. manufacturers with useful business services to become more competitive and productive. MEP's nationwide network serves to promote lean manufacturing techniques such as zero-defect quality programs. The program makes it possible for even the smallest firms to tap into specialists from across the country with manufacturing and business expertise in plant operations and on manufacturing floors. MEP clients have experienced more growth in labor productivity over a five-year period than similar non-client firms.[4]

MEP was originally intended to be comprised of 12 federally supported centers, with federal funding ending after six years. In its 15 years of operation, the program has expanded away from this original design to include 400 locations, and Congress has removed the sunset provision.[5] Given advances in manufacturing and technology, it is appropriate to evaluate MEP operations and take steps for continuous improvement. The administration proposes to coordinate MEP fully with other Commerce Department programs that are helping manufacturers to be more competitive and expand markets.

Through this coordination, the Commerce Department can more closely link the technical and business staff employed by the MEP centers located around the country with trade promotion specialists in the Commerce Department's International Trade Administration who are working with the proposed new Assistant Secretary for Manufacturing and Services. In addition, the ITA has experts with in-depth knowledge of and connections with various sectors of industry—automotive, textiles and apparel, energy, aerospace, machinery, metals, and microelectronics, to name a few. With a direct teaming of MEP field agents and these sector experts, the program can be a more effective national resource to help small manufacturers compete and succeed in the global marketplace.

Additionally, MEP should hold a recompetition for all MEP centers, with a focus on effectiveness and cost-efficiency. MEP should also explore methods, with Congress, for statutory authority to receive direct programmatic funding from private sector entities.

Wherever possible, MEP should also encourage applicants to identify areas of sector-specific expertise that could qualify them as a "center of excellence." MEP should encourage co-location with universities, community colleges, and ITA assistance centers to foster cooperation, knowledge transfer, greater efficiency, and manufacturing exports. The Technology Administration would lead the establishment of these centers by partnering with other organizations—including government at all levels as well as private sector organizations.

Encourage the Small Business Innovation Research and Small Business Technology Transfer Programs to Focus on Manufacturing

Two federal programs in particular exist to provide funding to small businesses to pursue R&D: the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. While results to date have been unclear, these programs can be a catalyst for greater innovation within small manufacturing enterprises. SBIR and STTR should place a higher priority on manufacturing R&D topics that would greatly leverage innovation in small and medium-size manufacturing companies.

Explore New Avenues for Leveraging the Unique Capabilities of U.S. National Laboratories and Universities for the Benefit of Small and Medium-sized Manufacturers

The National Institute of Standards and Technology, in collaboration with other federal agencies, and national laboratories, should explore the opportunity for establishing cooperative research programs on innovative manufacturing technologies among national laboratories, universities, the SBIR program, community colleges, and state and local technology-development associations. The objective should be to develop a working model of such arrangements that would provide the rapid diffusion of research successes into the private sector, provide access for small entrepreneurial businesses to sophisticated research tools, and provide training opportunities, such as for future nanotechnologists and nanomanufacturers. The current pace of technological change places a premium on expediting such initiatives. NIST should report its findings to the Secretary of Commerce in 2004.

Strengthening Education, Retraining, and Economic Diversification

To remain globally competitive, education and worker training strategies must be at the top of the national priority list. The administration successfully passed the No Child Left Behind Act in 2001, and is now working to fully implement this landmark education reform. The administration is also investing $1 billion over five years to improve math and science education.

In addition, under President Bush's leadership, the Departments of Commerce and Labor have worked together throughout the country to link workforce development efforts with economic development efforts. Important initiatives include the Department of Commerce's Economic Adjustment Program and the Department of Labor's new 21st Century Workforce Initiative, which strive to strengthen retraining systems that maintain the U.S. skills advantage in manufacturing. The Department of Labor's Employment and Training Administration invests approximately $10 billion a year in an array of workforce investment programs.

Building on that record should take the form of the steps set out below.

Enhance Workforce Skills Essential for Employment in Manufacturing Enterprises of the Future

Manufacturers across the country raised significant concerns about whether America was training the next generation of workers required to meet the needs of an increasingly high-tech workplace as well as to develop the manufacturing industries of the future. There was clear support for the development of improved vocational/technical training at both the secondary and post-secondary level, as well as for programs designed to improve

the skills of career-changing adults interested in manufacturing jobs. There was also support for improvements in basic math and science education, such as the current five-year, $1-billion initiative for a new math and science partnership program that will strengthen math and science teaching and education at all levels.

It is important to define the starting point for improving the skills and preparation of the U.S. workforce. Toward that end, the Department of Labor, in conjunction with the Departments of Commerce and Education, should undertake a benchmark analysis of the existing skills of the U.S. workforce and the future needs of the U.S. manufacturing sector. The effort should be designed to inform both programmatic changes at the federal level and suggestions for curricula at the local level.

The analysis should address ways that federal programs that support basic education for elementary and secondary students will prepare them to enter the workforce without the need for significant remedial education. The analysis should catalog the basic academic skills needed for individuals entering the manufacturing workforce and assess the extent to which primary and secondary education in the United States provide those skills.

The second step in the analysis goes to the specialized training needed to succeed in the manufacturing environment of the future. Historically, U.S. schools, particularly in secondary education, provided a number of opportunities for vocational training. Over time, these opportunities have declined, and the educational system has relied more heavily on specialized vocational-technical schools, at both the secondary and post-secondary level, to fill in the gap. The analysis should examine whether the existing system of vocational-technical education is sufficient to meet the needs of the U.S. manufacturing sector and should propose recommendations for change where needed.

Establish a High School and Technical Education Partnership Initiative

Congress should pass legislation creating a coordinated high schools and technical education improvement program, utilizing secondary and technical education state grants, as proposed in the president's budget for fiscal year 2004. This program would provide high-quality technical education through partnerships between high schools and postsecondary institutions. Such an initiative, administered by the Department of Education, would support secondary and postsecondary career and technical education programs in high-demand occupational areas. The high school component would include a challenging academic core to ensure that students in the program meet state achievement standards and obtain a clear pathway to further education beyond high school, through apprenticeship or postsecondary technical certificates and associate or baccalaureate degree programs. Such an initiative will ensure that students are being taught the necessary skills to make successful transitions from high school to college and college to the workforce.

Establish Personal Reemployment Accounts

In any period of economic adjustment, the most significant challenge is how best to ensure that workers who lose their jobs can successfully re-enter the workforce. The federal and state governments provide a number of programs designed to help workers find new jobs with training and re-employment assistance.

Toward that end, President Bush has proposed a Personal Reemployment Account initiative to assist Americans who need the most help getting back to work. This innovative approach to worker adjustment would offer accounts of up to $3,000 each to eligible individuals to purchase job training and key services, such

as child care and transportation, to help them look for a job and get back to work quickly. As a further incentive, recipients would be able to keep the balance of the account as a cash reemployment bonus if they become reemployed within 13 weeks. The Bush administration has included Personal Reemployment Accounts in its legislative proposal to reauthorize and reform the Workforce Investment Act.

Coordinate Economic Adjustment for Manufacturing Communities

Communities are hard hit when local manufacturing declines, particularly when a local factory accounts for much of the employment in a city or town. Just as individuals may need retraining to reenter the workforce, communities must, at times, develop alternative bases of economic development.

The federal government already has a number of programs available that can be used to develop the competitiveness of communities and support innovation in manufacturing. The challenge for communities often involves sorting out the purposes and requirements of those federal programs and how they might best be employed or tailored to local circumstances.

What is needed is an interagency federal task force, chaired by the Assistant Secretary of Commerce for Economic Development, to coordinate the efforts of relevant federal agencies, particularly the Departments of Labor and Education, in addressing the structural economic challenges faced by manufacturing-dependent communities. The task force would ensure that all federal agencies work together, coordinating resources and strategies to best provide a range of assistance to eligible communities. More specifically, the task force would provide a means of rapid response, identifying communities where the employment base is substantially dependent on only a few manufacturing companies and the communities that are at a significant risk of economic dislocation.

Given that early intervention and planning are critical for communities at risk, the first step the task force should take is to identify criteria for determining when a rapid response is needed. The task force would then work with the communities identified under these criteria to develop market-based development policies that seek to retain manufacturing jobs in a community, while beginning the efforts to diversify the economic base of the community.

Improve Delivery of Assistance for and Retraining of Displaced Workers

The challenges unfolding in manufacturing and in the job market represent a significant change from years past. Instead of individual industries facing particular adjustment issues due to stronger import competition, the U.S. economy in general is adjusting to fundamental changes underway in the world economy. While that process is particularly acute in the manufacturing sector, it extends broadly throughout the U.S. economy.

Current worker adjustment programs, in general, take one of two forms. The first involves the traditional suite of unemployment insurance and related programs that are designed with the individual worker in mind. That individual's employment prospects may or may not be related to more fundamental changes underway in the economy. The alternative form is the suite of trade adjustment assistance programs that fund extended unemployment and retraining for eligible workers. Here, eligibility is defined in terms of whether the employee can point to some direct trade impact that has displaced him or her from a job.

Neither of the current programs fully addresses the sort of adjustment underway in today's economy. What that calls

for is a fundamental reassessment of both types of programs to see how they might best be integrated into a coordinated approach to adjustment, reemployment, and retraining. Toward that end, the Commerce and Labor Departments, with the assistance of the Department of Education, should review the existing programs and provide recommendations on how best to integrate them into a coherent program that is dedicated to addressing the needs of workers affected by the ongoing adjustment in the rapidly changing economic environment.

This effort should build on the work currently underway through the Labor Department's High Growth Job Training Initiative. That initiative facilitates collaboration among employers, industry leaders, business associations, educators, community and technical colleges, and the public workforce system to tailor training programs to meet local workforce needs.

As part of this initiative, the Department of Labor is working with the manufacturing industry and others to conduct a nationwide review of workforce challenges. Key manufacturing sectors include electronics, motor vehicles, communications equipment, aerospace, plastics and pharmaceuticals. These sectors, and the manufacturing industry in general, are undergoing a transformation as a result of technological advances, requiring workers to adopt and perform new skills. Through collaborative efforts, the High Growth Job Training Initiative will identify those skills and work with institutions to develop successful training models.

In addition, Congress must pass the Bush administration's plan to strengthen the Workforce Investment Act. Annually, the Department of Labor spends $15 billion on the nation's "One-Stop" employment and job training system. Over 3,800 One-Stop centers provide services that enable workers to transform their skills in order to gain employment in emerging and growing industries. The administration is seeking to strengthen this system through the re-authorization of the Workforce Investment Act. Among the changes sought are to make funding more accessible through consolidation, to make the system more responsive to business needs, and to strengthen accountability.

Promoting Open Markets and a Level Playing Field

American manufacturers support an open trading system in which both they and their competitors face the same rules. Leveling the playing field internationally will require a three-part strategy:

1. It will require the encouragement of economic growth and the pursuit of trade agreements that eliminate barriers to exports of U.S. manufactured goods.

2. It should include the aggressive enforcement of current trade rules, particularly in the context of the World Trade Organization, to ensure compliance.

3. It should reinforce current efforts to promote exports of U.S. manufactured goods and services in growing foreign markets. Increasingly, those efforts must be adapted to the needs of U.S. manufacturers and service providers, particularly small and medium-sized businesses, by focusing on their ability not just to enter foreign markets, but also to become a part of global supply chains.

The following recommendations build on President Bush's strong commitment to ensure free and fair trade. They represent a further step toward fulfilling the three-part strategy outlined above.

Encourage Economic Growth and Open Trade and Capital Markets Abroad

One of the key features hampering both the prospects for a stronger recovery in U.S. manufacturing and ensuring a better balance in U.S. trade is the slow economic recovery among many major U.S. trading partners. The United States should encourage the adoption of growth-oriented economic policies as a means of spurring growth and expanding markets for U.S. manufacturers.

President Bush has taken the lead in promoting economic growth and open trade among America's trading partners. The coming year presents a number of significant opportunities to reinforce that effort, including G7 finance ministers' meetings, the G8 economic summit that the United States will host in June 2004, and the prospect of concluding trade agreements with a number of significant U.S. trading partners.

As President Bush has indicated, the goals of raising growth and increasing stability can best be accomplished in an international financial system that relies on the principles of free trade, free capital flows, and market-based flexible exchange rates among the major economies.

In addition, the following steps should be taken:

Encourage the Growth and Development of Foreign Capital Markets

Efficiently functioning capital markets are key to promoting economic growth. The United States should promote market-based prices and interest rates, including the phase-out of government subsidies and directed lending, in order to allocate capital more efficiently, raise productivity, and encourage economic growth.

Negotiate Liberalization of Markets for Financial Services in All Trade Agreements

Consistent with the Bush administration's proposal in the ongoing WTO negotiations, the United States should press for the elimination of all barriers to trade in financial services within the WTO and as a part of any bilateral or regional free trade arrangement, subject to prudential measures. Removing such barriers and introducing competition to the markets for financial services not only creates new market opportunities for U.S. services companies that serve U.S. manufacturers,

but also serves as a necessary predicate for efficiently functioning capital markets that are key to economic growth.

Negotiate Trade Agreements That Benefit U.S. Manufacturers

Most manufacturers believe that the most effective step that the U.S. government can take to promote a level playing field is to eliminate the barriers that inhibit market access for U.S. exports and to discipline the unfair trade practices that other countries use to afford their firms an unfair competitive advantage in the global marketplace. They also understood that doing so means strengthening engagement in the process of trade negotiations with America's trading partners.

The following steps would ensure that such negotiations focus on what counts for U.S. manufacturing:

Pursue the Elimination of Foreign Tariff and Non-tariff Barriers to Exports of U.S. Manufactured Goods

Among the highest priorities established by Congress in passing trade promotion authority was the elimination of tariff and non-tariff barriers to the export of U.S. manufactured goods through bilateral, regional, and multilateral agreements. The Bush administration's proposal on non-agricultural market access in the context of the ongoing WTO negotiations represents a model to be pursued in all negotiations. It would ensure the elimination of all tariffs on manufactured goods worldwide, thereby eliminating the current disparity between U.S. tariff levels and higher tariffs imposed by major trading partners on manufactured goods. Pursuing a counterpart strategy for non-tariff barriers is essential, particularly in industries like the automotive sector, where tariff barriers are already relatively low and non-tariff measures have become a significant means of barring U.S. access to foreign markets.

Negotiate the Elimination of Trade-distorting Subsidy Practices

Current international trade rules prohibit export subsidies, but they do not limit the means by which governments can confer a competitive advantage by subsidizing production at home. In future trade agreements, the United States should pursue the approach adopted by the administration in the context of WTO negotiations that seek to expand the existing prohibitions to include a broader range of subsidies as well as strengthen the rules against government financing of the private sector, including government involvement in, or distortion of, capital markets that insulate foreign firms from competition. In particular, future negotiations should pursue the elimination of the border adjustability of indirect taxes to address the disadvantages to countries relying primarily on direct taxes.

Enhance the Effectiveness of Trade Enforcement Tools

As the Bush administration has done in the context of the WTO negotiations, the United States should seek improvements in the tools available for the enforcement of trade agreements. Dispute settlement procedures should encourage the prompt resolution of disputes, as well as a reading of trade agreements that is consistent with the negotiators' intent. The administration should also pursue (within the WTO, bilateral or regional free trade arrangements, and other fora such as the current steel negotiations underway in the Organization for Economic Cooperation and Development) stronger mechanisms for countering trade practices that are not subject to existing or future trade disciplines.

Enforce U.S. Trade Agreements and Combat Unfair Trade Practices Affecting U.S. Manufacturers

American manufacturers are entitled to the benefits of the agreements that U.S. negotiators reach at the negotiating table. They are also entitled to the aggressive investigation of unfair trade practices that undercut those agreements, even where such actions are not subject to specific trade disciplines.

There are a variety of ways in which U.S. trade agencies could improve their approach to the enforcement of trade agreements and their response to foreign unfair trade practices. They include the following steps:

Reinforce the Efforts of the National Intellectual Property Enforcement Coordination Council

To the extent that U.S. investment in research and development provides a competitive edge in the marketplace, the protection of the intellectual property developed by U.S. manufacturers, which embodies the product of that research, becomes critical to the future of the manufacturing sector. The National Intellectual Property Enforcement Coordination Council—made up of the Commerce Department (including the USPTO), the United States Trade Representative, the Bureau of Customs and Border Protection, and the Department of Justice—is responsible for ensuring a coordinated approach to such efforts. It is time to reinforce the council's mission in two important respects. The first should be to promote the protection of U.S. intellectual property abroad by expanding cooperative efforts with developing country trading partners to encourage the full implementation of their obligations under the WTO's Agreement on Trade Related Aspects of Intellectual Property (TRIPS). One measure could include the placement of U.S. intellectual property experts within certain countries to provide in-country support. The second would involve the aggressive investigation of allegations of theft of intellectual property that would violate commitments made under TRIPS or similar provisions of bilateral or regional agreements, particularly allegations in which American manufacturers are compelled to divulge intellectual property as a condition of market access or investment.

Establish an Office of Investigations and Compliance within the Commerce Department

Congress created the position of Assistant Secretary of Commerce for Market Access and Compliance in order to improve the Commerce Department's focus on compliance with trade agreements as well as on their negotiation. The Assistant Secretary works closely with the USTR and the Trade Policy Staff Committee agencies to identify and pursue the elimination of foreign trade practices that violate U.S. trade agreements or distort markets to the disadvantage of American manufacturers and other sectors of the U.S. economy. To improve the Commerce Department's ability to support the USTR and investigate allegations of trade agreement violations and market-distorting practices, the Assistant Secretary for Market Access and Compliance should establish an office of investigations and compliance. That office should be staffed with skilled investigators trained in the development of the factual basis for potential enforcement action, particularly in those areas that have a significant effect on market access for U.S. manufactured goods.

Establish a Task Force within the Commerce Department's Import Administration to Pursue the Elimination of Foreign Unfair Trade Practices

Foreign unfair trade practices that distort markets represent a unique subset

of trade barriers. Current trade arrangements have significantly reduced the visible tariff and non-tariff barriers to trade worldwide. They do not, however, in every instance, impose disciplines on other forms of intervention in markets, such as subsidies, that governments may use to confer a competitive advantage on their firms. Unchecked, such actions not only can injure U.S. manufacturers, but also can significantly undercut the benefits of the trade agreements for U.S. producers while undermining support for the global trading system in general.

The existing international trade rules, as well as their counterparts in U.S. law, generally require that an industry prove injury from unfair trade practices in the context of either an antidumping or countervailing duty action before the U.S. government can take remedial action on its behalf. Furthermore, antidumping and countervailing duties at best only act indirectly to help eliminate the underlying unfair trade practices at the heart of U.S. industry's complaints.

The Assistant Secretary for Import Administration should form a task force to investigate allegations of such trade practices and develop a strategy for pursuing their elimination. This would eliminate the underlying distortions and thereby reduce the use of anti-dumping and countervailing duty actions. As part of that effort, the task force should review the implementation of current trade remedy rules, such as the procedures governing new shipper reviews. The Commerce Department should further establish an office within Import Administration to coordinate cases involving non-market economies in order to develop an experienced core of investigators familiar with the facts of such investigations and to ensure consistency in terms of the methodological approach.

Reinforce Efforts to Promote the Sale of American Manufactures in Global Markets

U.S. exports of manufactured goods have fallen significantly in the past two years. Although the pace of economic growth abroad appears to be accelerating, an expanded export promotion strategy should help ensure U.S. manufacturers have access to foreign markets that U.S. negotiators have opened. The following steps are designed to both improve the coordination of and accountability for U.S. export promotion activities, as well as to focus those efforts in a way that is consistent with the current challenges facing U.S. exporters of manufactured goods. The recommendations include:

Enhance the U.S. Government's Efforts on Behalf of U.S. Manufacturing by Consolidating Commerce Department Export Promotion Functions

Consolidation of all Commerce Department export promotion functions under a new Assistant Secretary for Trade Promotion, who would serve concurrently as the director general of the Commercial Service, would represent a solid first step toward improving the promotion of exports of manufactured goods in global markets. That consolidation would improve coordination and ensure accountability for the implementation of the National Export Strategy.

Accelerate Implementation of the President's National Export Strategy

Consistent with the legislation creating the Trade Promotion Coordinating Committee (TPCC), the administration published a comprehensive approach to improving the delivery of government export promotion services. The National Export Strategy contains a series of innovations designed to improve the promotion of U.S. exports. Given the sharp decline in U.S. exports in the recent past, the Commerce Department, as chair of the TPCC, should accelerate the implementation of

those innovations to improve the prospects for American manufacturers seeking new markets abroad.

Implement a Global Supply Chain Initiative to Promote Access to the Global Marketplace

Manufacturers at every roundtable reinforced the importance of focusing on access not just to export markets, but to global supply chains that would take American manufactured goods into the international stream of commerce. The Commerce Department, in conjunction with the TPCC, should develop and implement a joint public-private global supply chain initiative to promote access by America's small and medium-sized manufacturers into global supply chains.

As part of the initiative, the Commerce Department should assess the benefits of establishing new venues in major foreign commercial centers to enhance the services offered to U.S. exporters while in the country and to provide for on-the-ground expertise, including market research capabilities.

Promote Global Recognition and Use of U.S. Technical Standards

One significant means of expanding the access of small and medium-sized U.S. manufacturers to global supply chains is to encourage the adoption of U.S. technical standards in world markets for manufactured goods. With U.S. standards in place, a small or medium-sized U.S. manufacturer is, in effect, already "export ready," saving the manufacturer from the expense of satisfying more than one technical standard. Recognition and use of U.S. standards would have the additional benefit of reducing the ability of foreign governments to use technical specifications as a means to bar access to their markets for manufactured goods. Secretary Evans launched a global standards initiative in spring 2003 that was designed to achieve these objectives and to promote a private-sector based approach to standards development in other nations. The initiative should be accelerated and given a high priority by the various Commerce Department offices involved.

Update and Reauthorize U.S. Export Control Laws

Manufacturers in some sectors identified U.S. export control laws as an impediment to their competitiveness in international markets. Although necessary, such controls should be focused on truly sensitive goods and technologies consistent with U.S. national security concerns. The United States should work to ensure that such controls are applied uniformly by our multilateral export control regime partners. The administration should continue its support for the early passage of a revised Export Administration Act that would take into account the changes in technology and the international marketplace, as well as defense-acquisition practices.

The administration should also review the existing structure of the U.S. foreign-trade zone program to determine how it could be enhanced to provide a greater incentive to manufacture in the United States. The Commerce Department, which is responsible for administering the existing program, should do a benchmark analysis of how other countries make use of their foreign-trade zone mechanisms to determine whether there are features of those programs that the U.S. government should consider implementing, particularly as a means of lowering the cost of such programs for small and medium-sized businesses in the United States.

Notes

[1] The research and experimentation tax credit is commonly referred to by manufacturers as the R&D tax credit.

[2] President's Council of Advisors on Science and Technology, *Technology Transfer of Federally Funded R&D* (Washington, D.C.: President's

Council of Advisors on Science and Technology, May 2003).

[3] The Manufacturing Extension Partnership was created with the enactment of the Omnibus Trade Act of 1988 (Public Law 100-418).

[4] Researchers at the Census Bureau's Center for Economic Studies found that manufacturing extension clients experienced between 3.4 and 16 percent more growth in labor productivity over a five-year period than similar non-client firms. The productivity growth of the 1,559 firms studied translates into $484 million in additional value-added at client firms.

[5] The Technology Administration Act of 1998 (Public Law 105-309).

Appendix

List of Manufacturing Roundtables and Participants

High Point, N.C., April 23, 2003

Industry focus:

TEXTILES AND FURNITURE

Participants:

Sam Boyd
Pearson Company

Keith Crisco
Asheboro Elastics

Rob Ginn
Councill Furniture

Diane Howell
Kayser-Roth Corporation

Quez Little
Norwalk Furniture

Willis Moore
Unifi, Incorporated

Pat Norton
La-Z-Boy Furniture

Jerry Rowland
National Textiles

Anderson Warlick
Parkdale Mills

San Jose, Calif., May 8, 2003

Industry focus:

IT EQUIPMENT, TELECOMMUNICATIONS, COMPUTERS

Participants:

Bob Armistead
Aracor

Philip Fok
Solectron

Daryl Hatano
Semiconductor Industry Association

Greg Hines
Solectron

Cynthia Johnson
Agilent Technologies

Juri Matisoo
Semiconductor Industry Association

Fred Nichols
National Association of Manufacturers

Rockford, Ill., May 12, 2003

Industry focus:

HEAVY EQUIPMENT, TOOL AND DIE, MACHINERY

Participants:

Eric Anderberg
Dial Machine Corporation

Bruce Braker
Tooling and Manufacturing Association of Chicago

Bob Brunner
Illinois Tool Works

Thomas Burenga
Worksave, Inc.

Gerald Busse
Rockford Toolcraft, Inc.

Michael Cayley
MIDACO Corporation

Allan Curran
Royal Products

Lloyd Falconer
Seward Screw Products

Mary Rose Hennessey
NIU Biz Coalition for Manufacturing

Michael Hetzel
Americas for ProQC International

Bill Hickey
Latham-Hickey Steel Corp.

Phil James
Ingersol Production Co.

John Kaminski
E.D. Etnyre & Company

Alan D. Kinsler
Sellstrom Manufacturing

Bill Lee
Navagation Consulting Group

Richard Lingus
Rockford Consulting Group, Ltd.

Mike Lynch
Illinois Tool Works

Howard Newel
Hammil Tool

Alan Petrucci
BA Die Mold, Inc.

Dan Provonsano
Teletool Manufacturing

James J. Zawacki
GR Spring & Stamping, Inc.

Washington, D.C., May 20, 2003

Industry focus:

MACHINERY

Participants:

Jay Carlson
G&R Manufacturing

Richard Demsey
Demsey Manufacturing Co., Inc.

Chris Gemino and Robert Heche
Gaynor Electric Co., Inc.

Bob Hawie
Hawie Manufacturing

Frank Johnson
Manufacturing Alliance of Connecticut

George LaCapra
Quality Rolling & Deburring

Rich Larkin
Brown Larking & Co., LLC

Wells Lindsey
Manufacturing Service Corp.

Nick Masi
Masi Associates

David Niven
Dohnam Craft

Steve Sasala
Greater Waterbury Chamber of Commerce

Mark Stuart
National Association of Manufacturers

Bruce Thompson
Projects Incorporated

Joe Vrabely
Atlantic Steel & Processing, LLC

Manchester, N.H., May 29, 2003

Industry focus:

IT EQUIPMENT, TELECOMMUNICATIONS, COMPUTERS

Participants:

Raymond Boissoneau
Electropac Company

Mark Buck
Hypertherm

Marc Giroux
Corning, Inc.

Kedar Gupta
GT Equipment Technology

James (Giff) Kriebel
BAE Systems

Gerry Letendre
Diamond Casting & Machine Company

Hong Yu
Metrobility Optical Systems

Milwaukee, Wis., May 29, 2003

Industry focus:

FOOD PROCESSING, PACKAGING, HEAVY EQUIPMENT

Participants:

James Buchen
Wisconsin Manufacturers and Commerce

Mark Hardwick
P&H Mining Equipment

Joe Morrissey
Conflex, Inc.

Rick Patek
Telsmith, Inc.

Steven Polonowski
Krones, Inc.

Steve Tyler
CNH

Mike White
Rite-Hite Corporation

St. Louis, Mo., June 13, 2003

Industry focus:

CHEMICALS, AVIONICS, BIOTECHNOLOGY

Participants:

Bill Bachman
Bachman Machine Company

Robert Burns
Patriot Machine

Stewart Dahlberg
J.D. Street & Co.

Gerald Daniels
Engineered Support Systems

Kimberly Hayden
Supreme Tool & Die

Ray McCarty
Missouri Chamber of Commerce and Industry

Mike Mittler
Mittler Brothers Machine & Tool Company

Len Poli
M. Carder Industries

Kenneth Shead
IDS Boeing

Don Wainwright
Wainwright Industries

Summit, N.J., June 30, 2003

Industry focus:

PHARMACEUTICALS, BIOTECHNOLOGY

Participants:

Joseph Cherry
CR Bard

Joe Fusco
Novus Fine Chemicals

Stephen Greene
G&W Laboratories

William Healy
Health Care Institute of New Jersey

Michael Katz
Cenogenics

Christian Schade
Medarex

Washington, D.C., June 24, 2003

Industry focus:

MANUFACTURING IN 2020

Participants:

Arden Bement
NIST, Department of Commerce

Ron Blackwell
AFL-CIO

Cary Crouse
Delphi, Inc.

Tom Duesterberg
Manufacturers Alliance/MAPI

Steven Empedocles
Nanosys, Inc.

Juan Enriques-Cabot
Harvard Business School

Terry Lisenby
Nucor Steel, Inc.

Martha Morris
IBM

Leo J. Reddy
National Coalition for Advanced Manufacturing

Ross E. Robson
Shingo Prize for Excellence in Manufacturing

George Scalise
Semiconductor Industry Association

Amram Shapiro
Pittiglio, Rabin, Todd & McGrath

William Strauss
Federal Reserve Bank of Chicago

Michael Tieman
Red Hat Software

Tim Timken, Jr.
Timken Corporation

Bruce Tompkins
Institute of Industrial Engineers

Frank Vargo
National Association of Manufacturers

Jim Zawacki
FR Spring and Stamping

John Zysman
University of California at Berkeley

New Britain, Conn., July 7, 2003

Industry focus:

AEROSPACE, MACHINERY

Participants:

Lou Auletta
Bauer, Inc.

Murry Gerber
National Association of Manufacturers, Small and Medium Manufacturers Group

Frank Johnson
Manufacturing Alliance of Connecticut

Bill Lee
The Lee Company

Mick Mauer
Sikorsky Aircraft Group

Ted Malkowski
Continental Machine Company

Al Mulvey
Pratt & Whitney

Steve Prout
Alpha Q

John Salce
Hygrade Precision Technologies

Bruce Thompson
Projects, Inc.

Los Angeles, Calif., July 7, 2003

Industry focus:

MINORITY-OWNED AND SMALL MANUFACTURERS

Participants:

Candance Chen
Power Clean 2000, Inc.

Maria de Lourdes Sobrino
Lulu's Dessert

Frank Villalobos
Barrio Planners, Inc.

Linda Wong
Community Development Technologies Center

Columbus, Ohio, July 8, 2003

Industry focus:

METALS, TIRES, PLASTICS

Participants:

Lowell Dunckel
Goodyear

Steve Giangiordana
RTI International Metals

Mitchell Hecht
International Steel Group

Robert Stevens
Impact Forge

John Vaught
Tri-Cast

Trenton, N.J., July 8, 2003

Industry focus:

CHEMICALS

Participants:

Ashok Balar
Clariant Corporation

Hal Bozarth
Chemical Industry Council of New Jersey

W. Dexter Brown
National Starch and Chemical Company

William Fee
Magnesium Elektron, Inc.

Ron Fenn
Polarome International

Charles A. Lynch
New Jersey Commerce and Economic Growth Committee

Roger Madden
Church & Dwight

Salvatore Monte
Kenrich Petrochemical, Inc.

Ron Munson
Church & Dwight

Gerald Pechulis
Valero Energy

Gene Reinhardt
Dow Chemical

Jeff Stoller
New Jersey Business and Industry Association

Ed Van Ek
C.J. Holt

Detroit, Mich., July 9, 2003

Industry focus:

AUTOMOTIVE PARTS SUPPLIERS

Participants:

Christopher Bates
Motor & Equipment Manufacturers Association

Jason Brewer
E&E Manufacturing

Ron Cutter
TRW Automotive

Neil DeKoker
Original Equipment Suppliers Association

Sylvia Vogt
Robert Bosch Corporation

John Voorhorst
Denso International

Washington, D.C., July 10, 2003

Industry focus:

FOUNDRY

Participants:

Michael Beyersdorfer
Sawbrook Steel Casting Company

G. Edward Curtis
Harrison Steel Casting Company

Shane Downey
American Foundry Society

Jim Lajeunesse
Bronze Craft

Jim Mallory
Non-Ferrous Founders Society

Bill Martin
Neenah Foundry

Joe Mayer
Copper Brass Fabricators Council

Raymond Monroe
Steel Founders Society

Russell Symmes
Aluminum Foundries

Fred Wilton
Wilton Armetale Company

Chicago, Ill., July 10, 2003

Industry focus:

HIGH TECHNOLOGY

Participants:

Shail Godambe
Motorola, Inc.

Anthony Hilvers
IPC

Richard Paullin
Illinois District Export Council

Candy Renwall
Chicago Software Association

Ramesh Seth
S.I. Tech, Inc.

Mike Skarr
Naperville Chamber of Commerce

Robert Weskamp
Wes-Tech, Inc.

Ray Willis
Zuchem, Inc.

Des Moines, Iowa, July 11, 2003

Industry focus:

GENERAL MANUFACTURING

Participants:

Ralph Burchfield
Firestone Tires

Daniel B. Garry
3M

Alan Oak
Goodrich

Bob Jennings
EFCO

Christopher Nelson
Kemin Industries

Minneapolis, Minn., July 14, 2003

Industry focus:

MEDICAL DEVICES

Participants:

Daniel B. Garry
3M

Keith Guggenberger
Starkey Labs

Stephen Oesterle
Medtronic Inc.

Marge Searing
Advanced Medical Technology Association

Phillip Vierling
EMPI

Paul J. Wagner
Minnesota Wire and Cable

New Orleans, La., July 22, 2003

Industry focus:

ENERGY, ELECTRICITY, OIL AND GAS EQUIPMENT

Participants:

Guy Barone
Xenetech, Inc.

Chris Bollinger
Bollinger Shipyards, Inc.

Murphy Bourke
Gulf Island Fabrication

William Coyle
Bilco Tools, Inc.

Leo Guidroz
Oil Stop, LLC

Von Hatley
Louisiana Department of Economic Development

Rick Kelly
Pellerin Milnor Corporation

Allen Porter
Allen Process System

Brett Reagan
Point Eight Power, Inc.

Rodder Russo
Stabil Drill Specialties

Arthur Zatarain
TEST Automation & Controls

Washington, D.C., July 24, 2003

Industry focus:

AUTOMOBILE MANUFACTURING

Participants:

Edward Cohen
Honda

Steve Collins
Automotive Trade Policy Council

Josephine Cooper
Alliance of Automotive Manufacturers

Marie Kissel
DaimlerChrysler

Curt Magleby
Ford Motor Company

Tim McCarthy
Association of International Automobile Manufacturers

Mustafa Mohatarem
General Motors

Harland Reid
Nissan

Doug West
Toyota

Washington, D.C., Aug. 14, 2003

Industry focus:

WORKFORCE AND EDUCATION

Participants:

Sandra Carney-Talley
Aerospace Industries Association

Edward Dooley
Air-Conditioning and Refrigeration Institute

Phyllis Eisen
National Association of Manufacturers

James Hughes
Northrop Grumman

Steven Mandes
National Institute for Metalworking Skills

Dan Meckstroth
Manufacturers Alliance

Branka Minic
Manpower, Inc.

Tony Raimondo
Behlen Manufacturing

Michael Smeltzer
Manufacturers Association of South Central Pennsylvania

Richard Walker
National Tooling and Machining Association

Ft. Lauderdale, Fla., Aug. 19, 2003

Industry focus:

AEROSPACE

Participants:

Carlon Aaron
Hialeah Metal Spinning

Dan Becker
Boeing

Reynaldo Blanco
Florida Air Transport

Stan Bodner
Greater Miami Aviation Association

Ken Cooksey
Enterprise Florida

Michael Fatig
Honeywell, Inc.

Ken Krauter
New Port Director

Bill Lewandowski
Aerospace Industries Association

Sam Plummer
GEAR Technologies

Jim Roubian
HEICO Corporation

Kenneth Sitomer
VHL Aircraft Inc.

Al Stimak
Metal Essence

James Swanson
Swanson Tool

Washington, D.C., Sept. 5, 2003

Industry focus:

FOREST PRODUCTS

Participants:

George Glatfelter II
Glatfelter Company

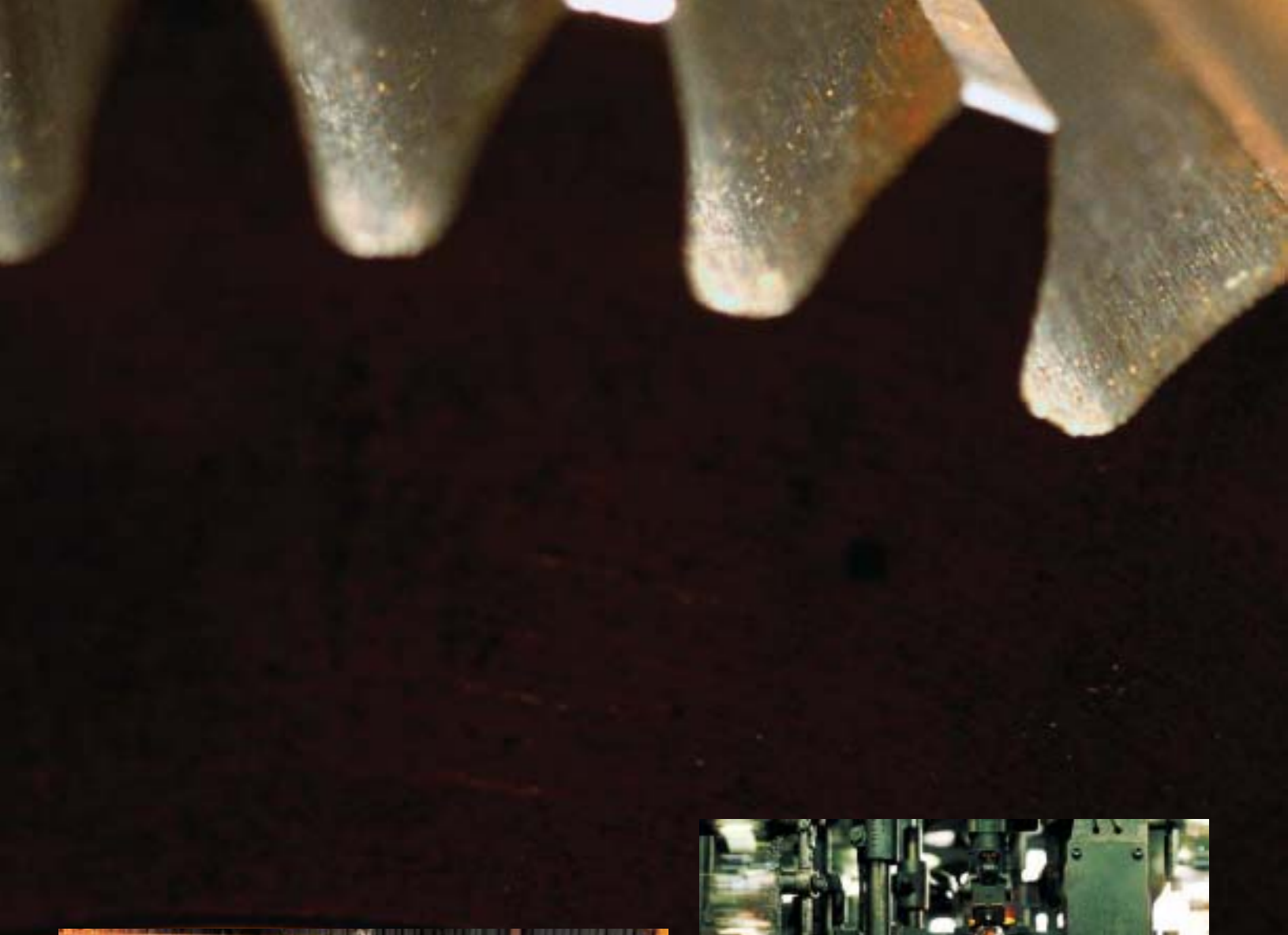
Donna Harman
American Forest and Paper Association

Kenneth Jastrow II
Temple-Inland, Inc.

John A. Luke, Jr.
MeadWestvaco Corporation

Henson Moore
American Forest and Paper Association

Arnold M. Nemirow
Bowater, Inc.



When the Industrial Base Goes Cold

by Peter J. Higgins

What happens if support for a key weapon system is jeopardized because repair parts are not available? The author discusses how the Department of Defense identifies and preserves at-risk capabilities.

The U.S. military relies heavily on private industry to develop and build the weapon systems and equipment it uses. But what happens to the weapons and equipment when requirements for their support and replacement decline and the producer decides to cease support? What short- and long-term problems arise when contractors decide not to remain part of the military-industrial complex, or to stop producing the essential components of a system on which our military depends? We must identify these problems early and find viable solutions to them.

First, we must determine which industrial capabilities are unique and vital to our national defense and if our military will be jeopardized when a company decides to terminate a vital activity or move production offshore. The national defense environment is dynamic, and, unfortunately, no single criteria applies in all situations. Identifying vital, at-risk capabilities requires program managers and other logisticians to become involved. Together, they are able to develop a strong, ongoing, mutually beneficial relationship with their counterparts in the private sector that helps to minimize the impact of a potential loss in capabilities.

Second, we must determine how logisticians can support that smaller force so that it remains credible and capable. This second determination is paramount, since in many ways it is easier to manage and support a large force, which has a large budget, inventory, support structure, and industrial base, than a minimally sized and resourced force. This is because the available support options and the redundancies in the support structure are fewer with the smaller force.

Since the end of the Cold War, the size of the U.S. military has decreased dramatically. At one time, the Navy envisioned a need for a 600-ship fleet. At the end of fiscal year (FY) 1988, the Navy had a total battle force of 566 ships. By the end of FY 1998, this number had dropped to approximately 330. In FY 1988, the Army had 18 active and 10 reserve divisions. Those numbers are now 10 and 8, respectively. Authorized end strength has decreased from approximately 2.2 million active duty military, 1.2 million reserve military, and 1.1 million civilian personnel in FY 1988 to approximately 1.4 million active duty military, 886,000 selected reserve, and 770,000 civilian personnel in FY 1998.

We now have a reduced force supported by a large infrastructure, which probably seems paradoxical to American taxpayers, particularly when our military, even though smaller,

is the preeminent military force in the world. However, reducing infrastructure means closing bases and reducing jobs, which are loathsome to politicians desiring re-election. Reduced infrastructure means fewer jobs, and that can mean lost votes.

Traditionally, reducing the size of our military, while maintaining core military competencies, has been difficult for the United States to achieve. The state of our military following World Wars I and II and the Vietnam War offers three examples. Each time, the post-drawdown military was weak and hollow, in large part because it was not a balanced force, and weapons modernization had lapsed.

As a natural consequence of today's smaller military force, materiel requirements are lower, and both the total Department of Defense (DOD) and acquisition budgets have been reduced dramatically. In FY 1988, DOD's budget authority was $374.6 billion compared to $250.7 billion in FY 1998 (using constant FY 1998 dollars)—a decrease of 33 percent. Budget authority (in constant FY 1998 dollars) for the DOD procurement account dropped from $101.8 billion in FY 1988 to $42.6 billion in FY 1998—a 58-percent drop in purchasing power. The result of these reduced budgets is that the readiness and sustainability of our military is threatened unless replacements for aging weapon systems or ways to extend their life are found. Unfortunately, systems modernization will occur only if money argued for in the Quadrennial Defense Review is made available or funding is added to the top line of the DOD budget. Compounding this problem, a number of long-standing niche contractors are less interested in the defense business, because reduced contract sizes equate to a bad risk-to-profit ratio.

Private Sector Business Practices

In the private sector, companies reduce expenses through economies of scale. In part, this helps to explain the number of mergers, consolidations, and acquisitions in the defense sector during the last few years. Combining operations eliminates duplicate overhead operations, inventories, and personnel.

Secretary of Defense William S. Cohen asked Congress for, and so far has been denied, two more rounds of base closures to free up money for weapons procurement and modernization, an action that mirrors the choices available to private enterprise. Secretary Cohen subsequently hinted at drastic steps to obtain additional weapons modernization funding, including allowing military bases to fall into disrepair and furloughing civilian DOD employees. The funds saved would be used to modernize some front-line systems by replacement or upgrade and to replace money siphoned off to pay for unbudgeted military operations in Bosnia and other locations.

Private industry is driven by profits it may earn and growth it can expect if it increases business volume and reduces costs. Corporate managers cannot be altruistic if they and their companies are to survive. Since DOD relies on defense contractors to produce the tools of war, it must allow contractors profit levels necessary to continue operations. Unfortunately, DOD is forced to operate within a limited budget, only a small portion of which is discretionary, and with a group of fairly fixed requirements.

Production Capabilities

As a result of fewer and smaller DOD contracts, some vital production capabilities unique to the defense industry are in jeopardy of being lost. For corporations to remain viable, their individual components must be profitable, or they will be shut down. This situation has grave consequences for DOD, particularly when the manufacturing processes at stake are unique to the defense industry. If any unique manufacturing capability is lost, how will DOD continue to support the affected weapon? What are DOD's options? These can be significant problems for our nation's warfighters as they develop their operational plans.

Unfortunately, some companies in specific market areas that rely exclusively on defense contracts are at risk. Obviously a problem is brewing, because defense contracts are both fewer and often of lower dollar value, and nondefense business alternatives are frequently less risky and potentially more profitable in the long run due to volume efficiencies.

The near-term potential for growth in the DOD budget is small because of the balanced budget agreement passed by Congress in 1996. DOD estimates that its budget will remain at the $250-billion level (plus inflation adjustments) for the next few years. This helps to explain DOD concerns, not only about weapons modernization, but also about maintaining the industrial base that supports military requirements.

What can DOD do if support for a key weapon system is jeopardized because essential repair parts are not available? During peacetime, DOD cannot coerce an industry or company to bid on work. In time of war, private industry can be required to perform military work. However, once a national emergency is declared, there may not be enough time to produce essential items in the quantities needed.

Identifying the Problem

The Industrial Capabilities and Assessments Directorate in the Office of the Deputy Under Secretary of Defense for Industrial Affairs and Installations is responsible for the policies and procedures used to identify at-risk capabilities. The actual assessments are performed on a case-by-case basis, and this occurs ideally at the lowest appropriate organizational level. However, when the capability issue affects more than one DOD program or product, the components coordinate their analyses and related decisions with any other affected DOD component or program. The Industrial Capabilities and Assessments Directorate usually leads or participates in these broad reviews.

These analyses are performed by appropriate representatives from the Services and the Office of the Secretary of Defense and experts hired to work for the study team under the direction of the Deputy Under Secretary of Defense for Industrial Affairs and Installations. When a potential problem with a manufacturing process important to DOD arises, here is how that group proceeds.

In their initial analysis, the Industrial Capabilities and Assessments Directorate determines if the problem is a routine management problem that the vendor can solve. If the vendor cannot solve the problem, and the situation is covered by any one of several scenarios, further analysis is performed. The first scenario occurs when DOD has a problem getting a needed product or service because the production rate is too low for the vendor to continue operations. The second occurs when a vendor or industry association warns DOD that low business volume endangers an industrial capability. The third happens when the capability is being terminated, either temporarily or permanently.

At first it may appear that there is little difference in these three scenarios. In each, the needed capability is threatened by economic, environmental, or other factors. Whatever the reason, a solution must be found if the capability is truly unique and its loss would jeopardize national security.

Assessing the Risk

When a capability issue meets the criteria described in one of the scenarios above, experts in the Industrial Capabilities and Assessments Directorate initiate a capabilities analysis. The analysis includes a review of financial documents to determine the result of operations and the justification for requests for support. It verifies that the potential for losing the capability exists, identifies and evaluates alternatives, and recommends a course of action. While the potential solutions are wide ranging, there is risk with any course of action or solution. No action may be required if the cost, time, and technical implications can be identified and the capability can be regenerated in the future, or if the capability will not be required in the future. Cost, of course, is always a consideration. Unfortunately, these capability analyses are usually complex and expensive.

The United States encourages foreign countries to compete for DOD contracts, which allows DOD to obtain an improved technology base at a competitive price. In fact, reciprocal procurement arrangements are in place with many nations that are potential suppliers for defense purposes. For example, an Israeli firm provided the air vehicle for the tactical unmanned aerial vehicle program. However, domestic source restrictions sometimes are placed on a program when a foreign source poses an unacceptable risk.

A substitute capability also may be an alternative, or the needed item or service may be obtained using different methods. Sometimes slight revisions to specifications can result in sufficient performance. For example, a mechanical gyroscope currently in use may be replaced with one that is based on laser technology.

Sometimes, when no substitute item or source can be found, DOD buys a sufficient quantity to meet all future needs. This "life-of-type" buy must be practical for the situation and may require congressional authorization. This solution is particularly useful for electronic items or as a stopgap measure until another viable solution is found.

A rather creative way to preserve an important capability involves a "smart shutdown." In this situation, production stops, but the essential elements of production are preserved.

Equipment and tooling are stored, personnel with needed skills are cataloged and tracked, the manufacturing process is photographed and videotaped, raw materials may be stockpiled, and computer-based models of the product are reproduced. Two issues should be analyzed when considering a smart shutdown: What is the expectation of restarting the activity, and would taking no action be a more effective option than a smart shutdown? For example, when current needs did not justify continued production, a smart shutdown was employed to maintain the capability to meet the Navy's future requirement for torpedoes.

Still another alternative may be to invest money to induce the vendor to maintain production. This solution also may involve directing maintenance work to the manufacturer or stretching out production, which is costly. Of course, the size of a contract may be increased by foreign military sales or finding civilian applications that also require the endangered process.

The partial spectrum of solutions offered above starts at the low-risk, low-cost end and progresses to those with greater risk and cost implications. This list is by no means exhaustive, and some other options or combination of options may be more appropriate depending on a specific situation. One longer range solution is for DOD to reduce its reliance on defense-unique industrial capabilities by increasing the use of commercial off-the-shelf hardware.

The difficult aspects of the capability issue are deciding which capabilities are at risk and the cost and time it may take to preserve them. Unfortunately, the costs involved can be quite large and the resource pool is finite. Because of limited budgets, all identified problems cannot be solved. This explains why certain criteria must be met before starting an analysis.

The industrial base capability issue is likely to become even bigger as both DOD and industry become smaller. In the end, the answers will be based on priority. Ultimately, as President Harry S. Truman said, "We must be prepared to pay the price for peace, or assuredly we will pay the price for war." **ALOG**

Peter J. Higgins is a logistics management specialist at the Army Logistics Management College, Fort Lee, Virginia, where he is an instructor in the Joint Course on Logistics. He holds a bachelor's degree in business administration from Roanoke College in Salem, Virginia.

ISM Report On Business®

ISM®
institute for supply management

The Value of the ROB

You see them each month — those figures reported in the Manufacturing and Non-Manufacturing ISM *Report On Business*®, but what do they really mean and how can you make them work for you?

As purchasing and supply professionals become more sophisticated with their approach to supply chains, it becomes imperative that they understand the value of economic data, and particularly the tools provided by ISM's Manufacturing and Non-Manufacturing Business Survey Committees, the groups in charge of providing the data results for the monthly reports. The Manufacturing ISM *Report On Business*® continues to provide an important measure by which to gauge the U.S. economy. It's the oldest of the two reports produced by the ISM Business Survey Committees. The Non-Manufacturing ISM *Report On Business*®, developed in 1998, is the most recent. Over the years, the ISM *Report On Business*® has served ISM members, government leaders, economists and the financial community as the source of several leading economic indicators. Today, many different organizations are using the Manufacturing and Non-Manufacturing ISM *Report On Business*® as a key source in assessing the U.S. and global economies.

On the first business day of the month, the Manufacturing ISM *Report On Business*® is released to the world. Shortly after the release at 10:00 a.m. Eastern Time, there is a teleconference with the major wire services. The morning continues with several live and taped radio interviews, and is followed with in-depth interviews by major print media. Given the advent of the many business Web sites on the Internet, the monthly releases are reviewed and evaluated in New York, Hong Kong, Tokyo, Sydney, London and Frankfurt at virtually the same time. So what exactly are in these reports sought by the media and economists each month?

The Whole Story

Each month's issue of *Inside Supply Management*® magazine brings readers a synopsis of the Manufacturing and Non-Manufacturing ISM *Report On Business*®. To view both reports in their entirety, visit the ISM Web site, **www.ism.ws**.

The Nuts and Bolts

The concept for the Manufacturing and Non-Manufacturing ISM *Report On Business*® surveys is quite simple. Each month, survey respondents from both the manufacturing and non-manufacturing sectors who make up the ISM Manufacturing and Non-Manufacturing Business Survey Committees (these individuals and their organizations remain anonymous) are asked to assess their organizations' performance based on a comparison of the current month to the previous month. Through the use of non-quantitative questions, they are asked if the level is "Better/Higher," "Same," or "Worse/Lower" than the preceding month. The resulting Manufacturing and Non-Manufacturing ISM *Report On Business*® indexes measure the rate and direction of change, if any, for each surveyed activity.

This questionnaire is sent to committee members each month requesting information on various areas of activity within their organizations. Results are given in the following indexes:

- PMI (composite index for Manufacturing sector only)
- NMI (composite index for Non-Manufacturing sector only)
- Business Activity (Non-Manufacturing sector only)
- Production (Manufacturing sector only)
- New Orders (from customers)
- Backlog of Orders (growing or declining)
- Supplier Deliveries
- Inventories
- Customers' Inventories (Manufacturing sector only)
- Inventory Sentiment (Non-Manufacturing sector only)
- Employment
- Prices
- New Export Orders
- Imports

Membership of the Manufacturing and Non-Manufacturing Business Survey Committees is diversified by the North American Industry Classification System (NAICS). To achieve a valid, weighted sample, participants are selected based on each industry's contribution to gross domestic product (GDP). For example, in the Manufacturing sector, transportation equipment (NAICS Class 336) — which includes auto and airplane production — has a higher weight, and therefore more members on the committee, than textile mills (NAICS Class 313-314).

What It Tells Us

The index that attracts the most attention in the ISM *Report On Business*® is the PMI. This index was created by Theodore Torda, an economist at the U.S. Department of

Commerce, and introduced in February 1982. The PMI provides a signal of the peaks and valleys in the manufacturing sector before they appear in government economic data. In recent years, the PMI has tended to lead manufacturers' profits. It's a composite of five of the indexes in the Manufacturing ISM *Report On Business*®, seasonally adjusted, with equal weights. The NMI, released in January 2008, is the composite index for the non-manufacturing sector and is comprised of four of the non-manufacturing indexes at equal weights.

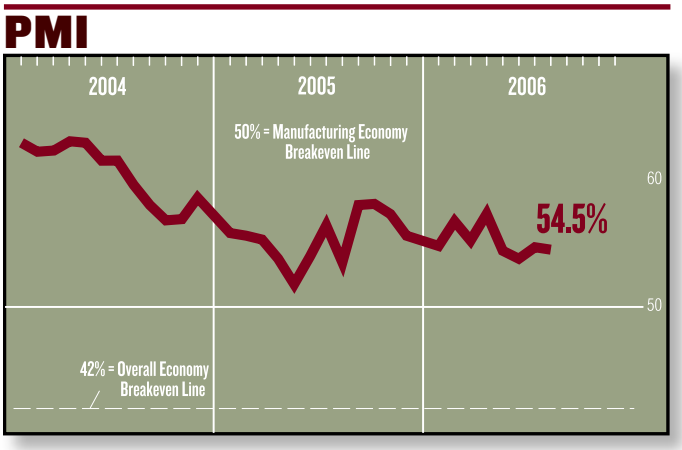
PMI	NMI
New Orders	New Orders
Production	Business Activity
Employment	Employment
Supplier Deliveries	Supplier Deliveries
Inventories	—

The ISM *Report On Business*® is considered by many economists to be the most reliable near-term economic barometer available. It is reviewed regularly by top government agencies, economists and business leaders for its timely, accurate information regarding the manufacturing and non-manufacturing sectors of the economy. Looking back at 2001, the Manufacturing ISM *Report On Business*® provided an accurate picture of the unique circumstances that shaped the global economy: the impact of the September 11 terrorist attacks. Although the September 2001 PMI at 46.2 percent was influenced by the attacks, the October PMI actually reflected the decline more as it fell 6.7 percentage points, an approximately 15 percent drop in manufacturing activity. This extended what might have been a very short and mild recession into a much deeper and lengthier event. Fortunately, the Federal Reserve had already lowered interest rates significantly to stimulate economic recovery, so the economy was able to benefit from the liquidity and the PMI bounced back, making up the decline by December with a reading of 48.1 percent. Prospects for 2002 improved as both the New Orders and Production Indexes rose above 50 percent, and the PMI strongly indicated overall growth in GDP.

During 2001, many goods-producing industries suffered through declining volumes and cost pressures. Hardest hit was the high-tech sector. While this sector weathered the Asian financial crisis in 1997 and 1998 quite well, it received a tremendous setback with huge numbers of order cancellations and growth plans that turned into survival plans. While the electronics industry was set on its heels, the telecommunications business was devastated. Excess capacity, reduced capital spending and falling prices were evidenced in every sector of manufacturing with the exception of the food industry.

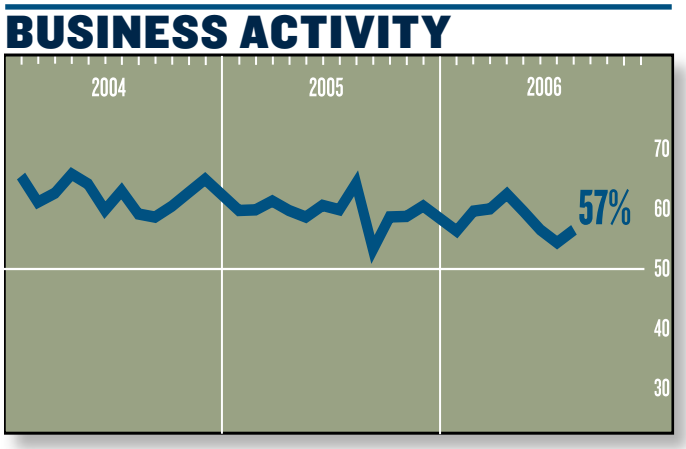
How Supply Managers Use the Data

The information released each month in the Manufacturing and Non-Manufacturing ISM *Report On Business*® is only of value if professionals can apply the knowledge to their activities. Here are some ways that supply managers can use the data:



The PMI, above, provides a signal of the peaks and valleys in the manufacturing sector before they appear in government economic data. It, along with other indexes like the New Orders and Production Indexes, are used by professionals to predict future growth or contraction.

- Acquire an understanding of the capability of each of the indexes. The PMI, New Orders and Supplier Deliveries Indexes are leading indicators (typically by one or more months) and predictors of future growth or contraction. The Production Index is a coincidental indicator that historically correlates with the Federal Reserve Board's Index of Industrial Production, and is a good indicator of current production. The Inventories, Employment and Prices Indexes are considered lagging indicators and change as a result of variations in New Orders and Production.
- Trends can be plotted from the Prices Index to aid interpretation of the direction and rate of change. The Prices Index is considered by many to be a good indication of future inflation — a great concern earlier in this decade. Expectations are that it will also aid in analyzing deflation, should this become an issue.
- Each release of the Manufacturing and Non-Manufacturing ISM *Report On Business*® includes a list of commodities that are reported up or down in price. Close scrutiny of this list will provide early indications of actual price changes and any trends of continuing price movement.
- Check the Short Supply List. In recent months, survey members have reported few items in short supply, an indication that supply has been leading the demand for most products. Historically, this list has been very useful in identifying potential supply bottlenecks.
- The Buying Policy can be used to measure changes in capital investment, just-in-time deliveries, and maintenance, repair, and operating purchases. As an example, survey members are queried about their Buying Policy with regard to capital. They provide their current commitment based on average number of days.
- The Manufacturing ISM *Report On Business*® is used to forecast expansion or contraction in certain industries. Studies have correlated the PMI to growth in gross domestic product (GDP). Using the coefficient of percent change in GDP, it is possible to predict expansion or contraction in any of the NAICS manufacturing



The Business Activity Index, above, gauges activity in the Non-Manufacturing sector. Comparable to the Production Index in the Manufacturing ISM *Report On Business*®, the Business Activity Index measures the rate and direction of change, if any, in the level of business activity.

categories. This allows supply professionals to predict their own industry or that of their major suppliers.

- The ISM *Report On Business*® is used in numerous organizations as a leading indicator of other economic indexes. This is a more sophisticated use of the report and requires a monthly revision of the analysis. The ISM Business Survey Committees rely on assistance from the U.S. Department of Commerce to develop correlation to other indexes as validation of the monthly data. The ISM Business Survey Committees also assist these power users with information and explanations, but the development and interpretation is left to the user.

What Is a Diffusion Index?

Diffusion indexes have the properties of leading indicators and are convenient summary measures showing the prevailing direction of change. The percent response to the "Better," "Same" or "Worse" question is difficult to compare to prior periods. Therefore, the percentages are "diffused" for this purpose. A diffusion index takes those indicating "Better" and half of those indicating "Same" and adds the percentages. This effectively measures the bias toward a positive (above 50 percent) or negative index (below 50 percent). For example, if the response is 20 percent "Better," 70 percent "Same," and 10 percent "Worse," then the diffusion index would be 55 percent (20% + (0.50 x 70%)).

The data for each question is converted to a diffusion index and then seasonally adjusted. (Manufacturing ISM *Report On Business*® data is seasonally adjusted for the PMI, New Orders, Production, Employment, Supplier Deliveries and Inventories. Data for the Non-Manufacturing ISM *Report On Business*® is seasonally adjusted for Business Activity, New Orders, Prices and Employment.) The seasonal adjustment factors are provided to the ISM Business Survey Committee by the U.S. Department of Commerce. This allows for the effects of repetitive intra-year variations resulting primarily from differences in weather conditions, various institutional arrangements and non-movable holidays. Though typically minor, seasonal adjustments add to the credibility of the Manufacturing ISM *Report On Business*®.

For each index, a reading above 50 percent indicates expansion of an index, while a reading below 50 percent indicates it is generally declining. And a reading of 50 percent indicates "no change" from the previous month. Supplier Deliveries is an exception. A Supplier Deliveries Index above 50 percent indicates slower deliveries, and below 50 percent indicates faster deliveries.

Business Cycles

Supply managers are far more aware than most of business cycles. They tend to think in terms of "buyer's markets" versus "seller's markets." Identifiable business cycles date back to the middle of the 19th century. Business cycles have a definite impact on sourcing strategies, and supply managers who are sensitive to upward and downward trends will be more effective in managing their supply network costs.

Business cycles are subject to dramatic variability. Both the length of the expansions and contractions and the intensity of the highs and lows are always unique to the cycle. Recent U.S. business cycles have been longer than average, and world events have played major roles (1973 oil embargo; 1991 Mexican financial crisis; 1997 Asian economic crisis; the September 11 attacks in 2001; and Hurricanes Katrina and Rita in 2005). A paradox is that the U.S. economy has been extremely well managed (high productivity, low government deficits, low interest rates) during the last decade, but has been slowed by major events. This offers proof that supply professionals must think globally even if they are not directly involved globally.

Follow the Trends

Even seasoned economists fall into the trap of looking at one month's data and developing a forecast for the future. Supply managers need to constantly remind themselves of two basic tenets:

- React to trends, not the monthly data. Don't assume that a change in direction in an index is the beginning of a change in direction for the manufacturing or non-manufacturing sector. Cycles tend to rise and fall in sawtooth movements. Computing a quarterly moving average will smooth the normal oscillations of the market.
- In every economic scenario, there is a winner and a loser. Even in a robust economy, there are industries struggling with growth due to over-capacity, loss of markets or new competition. Just as in the stock market, where every transaction involves a seller — who thinks the stock price will go down — and a buyer — who thinks the stock price will go up — there is always someone, somewhere, benefiting from the business cycle. In another example, falling oil prices are devastating to producing countries and to certain areas of the United States; however, they have a very positive impact on the U.S. trade deficit.

ISM *Report On Business*® Provides Early Recognition of Change in the Business Cycle

Since its inception in 1920, ISM's *Report On Business*® has grown to be one of the most widely respected economic indicators available. In 2004, the Federal Reserve Bank of Richmond's *Economic Quarterly* described the reports as "highly regarded by business analysts because they have proven to be a reliable gauge of economic activity over a long period." And while the ISM indexes provide an early warning system for the U.S. economy, the methodology developed over the years now plays an ever-increasing role in measuring global economic performance.

The greatest value of the type of data contained in the ISM *Report On Business*® may be in its ability to recognize change. Understanding the business cycle is important to the financial community, government policy-makers and to the businesses around the globe. But, the early recognition of change in the business cycle plays an even more significant role. In the United States, government policy-makers used the ISM data as a dependable early read on the U.S. economy after the September 11 attacks on the World Trade Center, and the ISM data did not fail them. The October 2001 data reflected the tremendous jolt that the U.S. economy absorbed, and the ensuing months showed a steady recovery. The data became even more important as it provided measures of economic activity during the 2001-02 recession in the United States.

Beyond measuring change, the ISM *Report On Business*® has also proven reliable in tracking movements in gross domestic product (GDP) in real time, as there is a high correlation between the ISM Manufacturing Production Index and the Non-Manufacturing Business Activity Index when measured against real GDP (see chart below). The significance of this type of correlation is that the monthly ISM data provides insight into conditions that can't be otherwise confirmed until other economic data is consolidated four to six months later.

While predicting the actual performance of the manufacturing sector is always a challenge, one thing is certain: Those purchasing and supply professionals who continue to analyze that data and use it as a forecast and economic tool will have the advantage.

By Norbert J. Ore, C.P.M., ISM Manufacturing Business Survey Committee chair; and group director, strategic sourcing and procurement for Georgia-Pacific LLC.

Non-Manufacturing Sector Plays a Significant Role in Economy

The non-manufacturing sector currently makes up more than 80 percent of the gross domestic product (GDP). In addition to purchasing materials for production, manufacturing businesses also source for services from various non-manufacturing industries. Virtually every business is impacted by business activity in the non-manufacturing sector.

Because of the significant impact business activity within the non-manufacturing sector has on the economy, in 1998 ISM began issuing the Non-Manufacturing *Report On Business*® with results from purchasing and supply executives responding from the non-manufacturing sector.

Released on the third business day of the month, the Non-Manufacturing ISM *Report On Business*® provides data results for business activity, new orders, backlog of orders, new export orders, inventories, inventory sentiment, imports, prices, employment and supplier deliveries. In addition, the report lists commodities that respondents indicate are increasing or decreasing in price, as well as commodities reported in short supply for the month surveyed.

Beginning in January 2008, ISM began calculating a composite index for the non-manufacturing sector. The Non-Manufacturing Index (NMI) is a composite index based on the diffusion indexes for four of the indicators with equal weights: Business Activity (seasonally adjusted), New Orders (seasonally adjusted), Employment (seasonally adjusted) and Supplier Deliveries.

The lead index of the Non-Manufacturing ISM *Report On Business*® is the NMI, which is comparable to the PMI in the Manufacturing ISM *Report On Business*®.

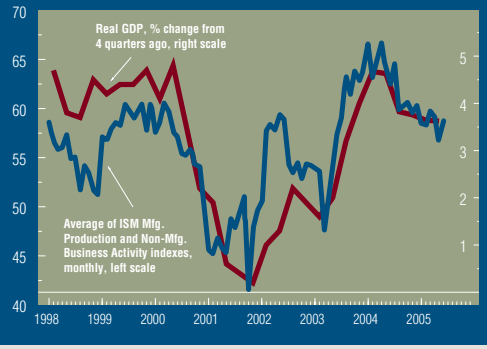
Reviewing the monthly NMI enables supply management professionals to further assess current and future business strategies and make adjustments as necessary. The Index is particularly helpful in developing commodity strategies and supplier collaborations.

By Anthony S. Nieves, C.P.M., CFPM, chair of the ISM Non-Manufacturing Business Survey Committee; and senior vice president – supply management for Hilton Hotels Corporation.

Real GDP and ISM Indexes

There is a correlation between the ISM indexes and real GDP, as illustrated in this chart. The red line represents real GDP and follows the scale on the right, which shows the percentage change from four quarters ago. The blue line reflects the average of the ISM Manufacturing Production Index and the ISM Non-Manufacturing Business Activity Index; it follows the scale on the left.

Source: **U.S. Department of Commerce**



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November 2008 Manufacturing ISM *Report On Business*®

PMI at 36.2%

DO NOT CONFUSE THIS NATIONAL REPORT with the various regional purchasing reports released across the country. The national report's information reflects the entire United States, while the regional reports contain primarily regional data from their local vicinities. Also, the information in the regional reports is not used in calculating the results of the national report. The information compiled in this report is for the month of November 2008.

New Orders, Production, Employment and Inventories Contracting
Prices Falling
Supplier Deliveries Faster

(Tempe, Arizona) — Economic activity in the **manufacturing sector** failed to grow in November for the fourth consecutive month, and the **overall economy** contracted for the second consecutive month, say the nation's supply executives in the latest **Manufacturing ISM *Report On Business***®.

The report was issued today by Norbert J. Ore, C.P.M., chair of the Institute for Supply Management™ Manufacturing Business Survey Committee. "When comparing November to October, the PMI indicates a continuing rapid rate of contraction in manufacturing. New orders have contracted for 12 consecutive months, and are at the lowest level since June 1980 when the index registered 24.2 percent. Order backlogs have fallen to the lowest level since ISM began tracking the Backlog of Orders Index in January 1993. The Prices Index at 25.5 percent indicates that commodity prices continue to decline at a rapid rate. This is the lowest reading for the index since May 1949 when it registered 20.1 percent."

PERFORMANCE BY INDUSTRY

The two industries reporting growth in November — listed in order — are: Apparel, Leather & Allied Products; and Paper Products. The industries reporting contraction in November are: Nonmetallic Mineral Products; Fabricated Metal Products; Textile Mills; Printing & Related Support Activities; Machinery; Electrical Equipment, Appliances & Components; Primary Metals; Transportation Equipment; Furniture & Related Products; Plastics & Rubber Products; Computer & Electronic Products; Chemical Products; Petroleum & Coal Products; Miscellaneous Manufacturing; Food, Beverage & Tobacco Products; and Wood Products.

WHAT RESPONDENTS ARE SAYING ...

- "The only positive thing of late is that the U.S. dollar has strengthened significantly against other currencies. We import the majority of our materials so this will have the effect of lowering our COGS." (Transportation Equipment)
- "Steel industry is our main customer, and they have had a real slowdown." (Computer & Electronic Products)
- "Criteria for projects is significantly higher with very short ROI periods." (Food, Beverage & Tobacco Products)
- "We have revised downward our top-line sales estimates for CY2009 by 8 percent due to the continued softness we see in the housing sector." (Machinery)
- "Suppliers are trying to hold onto pricing, but petrochemical and commodity prices are dropping like a rock." (Plastics & Rubber Products)

MANUFACTURING AT A GLANCE NOVEMBER 2008						
Index	**Series Index November**	**Series Index October**	**Percentage Point Change**	**Direction**	**Rate of Change**	**Trend* (Months)**
PMI	36.2	38.9	-2.7	Contracting	Faster	4
New Orders	27.9	32.2	-4.3	Contracting	Faster	12
Production	31.5	34.1	-2.6	Contracting	Faster	3
Employment	34.2	34.6	-0.4	Contracting	Faster	4
Supplier Deliveries	48.4	49.2	-0.8	Faster	Faster	2
Inventories	39.1	44.3	-5.2	Contracting	Faster	5
Customers' Inventories	55.0	55.0	0	Too High	Same	4
Prices	25.5	37.0	-11.5	Decreasing	Faster	2
Backlog of Orders	27.0	29.5	-2.5	Contracting	Faster	7
Exports	41.0	41.0	0	Contracting	Same	2
Imports	37.5	41.0	-3.5	Contracting	Faster	10
OVERALL ECONOMY				Contracting	Faster	2
Manufacturing Sector				Contracting	Faster	4

*Number of months moving in current direction

COMMODITIES REPORTED UP/DOWN IN PRICE and IN SHORT SUPPLY

Commodities Up in Price

Caustic Soda (9); Copper (2)*; and Natural Gas*.

Commodities Down in Price

Aluminum (2); Aluminum Based Products; Copper* (4); Diesel Fuel (4); #2 Fuel Oil; Gasoline; Natural Gas* (4); Nickel (2); Polyethylene; Polypropylene (2); Resin Based Products; Scrap Steel; Stainless Steel (2); Steel (3); Steel — Cold Rolled (2); Steel Products; Steel Scrap Surcharges; and Sulfuric Acid.

Commodities in Short Supply

Caustic Soda (9) is the only commodity reported in short supply.

Note: The number of consecutive months the commodity is listed is indicated after each item.

*Reported as both up and down in price

NOVEMBER 2008 MANUFACTURING INDEX SUMMARIES

PMI

Manufacturing contracted in November as the PMI registered 36.2 percent, 2.7 percentage points lower than the 38.9 percent reported in October. This is the lowest reading since May 1982 when the PMI registered 35.5 percent. A reading above 50 percent indicates that the manufacturing economy is generally expanding; below 50 percent indicates that it is generally contracting.

A PMI in excess of 41.1 percent, over a period of time, generally indicates an expansion of the overall economy. Therefore, the PMI indicates contraction in both the overall economy and the manufacturing sector. Ore stated, "The past relationship between the PMI and the overall economy indicates that the average PMI for January through November (46.8 percent) corresponds to a 1.8 percent increase in real gross domestic product (GDP). In addition, if the PMI for November (36.2 percent) is annualized, it corresponds to a 1.5 percent decrease in real GDP annually."

THE LAST 12 MONTHS

Month	*PMI*		*Month*	*PMI*
Nov 2008	36.2		May 2008	49.6
Oct 2008	38.9		Apr 2008	48.6
Sep 2008	43.5		Mar 2008	48.6
Aug 2008	49.9		Feb 2008	48.3
Jul 2008	50.0		Jan 2008	50.7
Jun 2008	50.2		Dec 2007	48.4
Average for 12 months — 46.9 High — 50.7 Low — 36.2				

New Orders

ISM's New Orders Index registered 27.9 percent in November, 4.3 percentage points lower than the 32.2 percent registered in October. This is the lowest reading for this index since June 1980 when the index was at 24.2 percent. A New Orders Index above 51.6 percent, over time, is generally consistent with an increase in the Census Bureau's series on manufacturing orders (in constant 2000 dollars).

Petroleum & Coal Products is the only industry reporting increased new orders during November. The industries failing to grow in November are: Nonmetallic Mineral Products; Printing & Related Support Activities; Textile Mills; Primary Metals; Plastics & Rubber Products; Fabricated Metal Products; Machinery; Transportation Equipment; Electrical Equipment, Appliances & Components; Paper Products; Furniture & Related Products; Chemical Products; Food, Beverage & Tobacco Products; Miscellaneous Manufacturing; and Computer & Electronic Products.

New Orders	% Better	% Same	% Worse	Net	Index
Nov 2008	12	29	59	-47	27.9
Oct 2008	13	35	52	-39	32.2
Sep 2008	18	43	39	-21	38.8
Aug 2008	23	48	29	-6	48.3

Production

ISM's Production Index decreased to 31.5 percent in November, a decrease of 2.6 percentage points from the 34.1 percent reported in October. An index above 49.9 percent, over time, is generally consistent with an increase in the Federal Reserve Board's Industrial Production figures.

Of the industries reporting in November, only one registered growth: Paper Products. The industries failing to grow in November are: Nonmetallic Mineral Products; Textile Mills; Furniture & Related Products; Primary Metals; Printing & Related Support Activities; Plastics & Rubber Products; Fabricated Metal Products; Transportation Equipment; Petroleum & Coal Products; Machinery; Electrical Equipment, Appliances & Components; Food, Beverage & Tobacco Products; Chemical Products; Miscellaneous Manufacturing; Computer & Electronic Products; and Wood Products.

Production	% Better	% Same	% Worse	Net	Index
Nov 2008	12	38	50	-38	31.5
Oct 2008	11	43	46	-35	34.1
Sep 2008	20	47	33	-13	40.8
Aug 2008	21	61	18	+3	52.1

Employment

ISM's Employment Index registered 34.2 percent in November, which is a decrease of 0.4 percentage point when compared to the 34.6 percent reported in October. This is the lowest reading for the Employment Index since March 1991 when the index registered 33.6 percent. An Employment Index above 49.5 percent, over time, is generally consistent with an increase in the Bureau of Labor Statistics (BLS) data on manufacturing employment.

The two industries reporting growth in employment during November are: Apparel, Leather & Allied Products; and Miscellaneous Manufacturing. The industries that reported decreases in employment during November are: Nonmetallic Mineral Products; Printing & Related Support Activities; Fabricated Metal Products; Furniture & Related Products; Computer & Electronic Products; Textile Mills; Machinery; Electrical Equipment, Appliances & Components; Plastics & Rubber Products; Wood Products; Chemical Products; Primary Metals; Transportation Equipment; and Food, Beverage & Tobacco Products.

Employment	% Higher	% Same	% Lower	Net	Index
Nov 2008	8	51	41	-33	34.2
Oct 2008	7	53	40	-33	34.6
Sep 2008	8	65	27	-19	41.8
Aug 2008	17	63	20	-3	49.7

Supplier Deliveries

The delivery performance of suppliers to manufacturing organizations was faster for the second consecutive month in November as the Supplier Deliveries Index registered 48.4 percent, which is 0.8 percentage point lower than the 49.2 percent registered in October. A reading above 50 percent indicates slower deliveries.

The five industries reporting slower supplier deliveries in November are: Wood Products; Plastics & Rubber Products; Primary Metals; Chemical Products; and Machinery. The industries reporting faster deliveries in November are: Nonmetallic Mineral Products; Electrical Equipment, Appliances & Components; Fabricated Metal Products; Food, Beverage & Tobacco Products; and Transportation Equipment.

Supplier Deliveries	% Slower	% Same	% Faster	Net	Index
Nov 2008	6	84	10	-4	48.4
Oct 2008	9	80	11	-2	49.2
Sep 2008	11	84	5	+6	52.5
Aug 2008	9	84	7	+2	50.3

Inventories

Manufacturers' inventories contracted in November as the Inventories Index registered 39.1 percent, which is 5.2 percentage points lower than the 44.3 percent reported in October. An Inventories Index greater than 42.4 percent, over time, is generally consistent with expansion in the Bureau of Economic Analysis' (BEA) figures on overall manufacturing inventories (in chained 2000 dollars).

The four industries reporting higher inventories in November are: Plastics & Rubber Products; Paper Products; Furniture & Related Products; and Food, Beverage & Tobacco Products. The

industries that reported decreases in November are: Petroleum & Coal Products: Miscellaneous Manufacturing; Electrical Equipment, Appliances & Components; Chemical Products; Computer & Electronic Products; Fabricated Metal Products; Primary Metals; Machinery; and Transportation Equipment.

Inventories	% Higher	% Same	% Lower	Net	Index
Nov 2008	13	51	36	-23	39.1
Oct 2008	16	55	29	-13	44.3
Sep 2008	13	60	27	-14	43.4
Aug 2008	18	65	17	+1	49.3

Customers' Inventories*

The ISM Customers' Inventories Index registered 55 percent in November, the same as reported in October. The index indicates that respondents believe their customers' inventories are too high at this time.

Eight industries reported higher customers' inventories during November: Textile Mills; Furniture & Related Products; Machinery; Plastics & Rubber Products; Primary Metals; Food, Beverage & Tobacco Products; Fabricated Metal Products; and Chemical Products. The industries that reported lower customers' inventories during November are: Wood Products; Miscellaneous Manufacturing; Nonmetallic Mineral Products; Printing & Related Support Activities; and Transportation Equipment.

Customers' Inventories	% Reporting	%Too High	%About Right	%Too Low	Net	Index
Nov 2008	70	31	48	21	+10	55.0
Oct 2008	77	28	54	18	+10	55.0
Sep 2008	77	23	61	16	+7	53.5
Aug 2008	66	22	65	13	+9	54.5

Prices*

The ISM Prices Index registered 25.5 percent in November compared to 37 percent in October, indicating manufacturers are paying lower prices on average when compared to October. This is the lowest reading for the index since May 1949 when it registered 20.1 percent. While 8 percent of respondents reported paying higher prices and 57 percent reported paying lower prices, 35 percent of supply executives reported paying the same prices as the preceding month. A Prices Index above 47.4 percent, over time, is generally consistent with an increase in the Bureau of Labor Statistics (BLS) Index of Manufacturers Prices.

In November, Apparel, Leather & Allied Products is the only industry reporting paying higher prices. The industries that reported paying lower prices during November are: Nonmetallic Mineral Products; Wood Products; Fabricated Metal Products; Machinery; Food, Beverage &

Tobacco Products; Paper Products; Plastics & Rubber Products; Furniture & Related Products; Electrical Equipment, Appliances & Components; Primary Metals; Transportation Equipment; Chemical Products; Miscellaneous Manufacturing; and Computer & Electronic Products.

Prices	% Higher	% Same	% Lower	Net	Index
Nov 2008	8	35	57	-49	25.5
Oct 2008	14	46	40	-26	37.0
Sep 2008	30	47	23	+7	53.5
Aug 2008	60	34	6	+54	77.0

Backlog of Orders*

ISM's Backlog of Orders Index registered 27 percent in November, 2.5 percentage points lower than the 29.5 percent reported in October. Of the 89 percent of respondents who reported their backlog of orders, 6 percent reported greater backlogs, 52 percent reported smaller backlogs, and 42 percent reported no change from October.

The only industry reporting an increase in order backlogs in November is Apparel, Leather & Allied Products. The industries that reported decreases in order backlogs during November are: Nonmetallic Mineral Products; Paper Products; Textile Mills; Printing & Related Support Activities; Machinery; Fabricated Metal Products; Electrical Equipment, Appliances & Components; Computer & Electronic Products; Primary Metals; Plastics & Rubber Products; Chemical Products; Food, Beverage & Tobacco Products; Wood Products; Transportation Equipment; Furniture & Related Products; and Miscellaneous Manufacturing.

Backlog of Orders	% Reporting	% Greater	% Same	% Less	Net	Index
Nov 2008	89	6	42	52	-46	27.0
Oct 2008	87	9	41	50	-41	29.5
Sep 2008	83	10	50	40	-30	35.0
Aug 2008	87	15	57	28	-13	43.5

New Export Orders*

ISM's New Export Orders Index registered 41 percent in November, the same rate of contraction reported in October. This is the second month of contraction following 70 consecutive months of growth in the New Export Orders Index.

The two industries reporting growth in new export orders in November are: Apparel, Leather & Allied Products; and Plastics & Rubber Products. The industries that reported decreases in new export orders in November are: Nonmetallic Mineral Products; Printing & Related Support Activities; Paper Products; Machinery; Primary Metals; Miscellaneous Manufacturing; Fabricated Metal Products; Electrical Equipment, Appliances & Components; Computer &

Electronic Products; Transportation Equipment; Food, Beverage & Tobacco Products; and Chemical Products.

New Export Orders	% Reporting	% Higher	% Same	% Lower	Net	Index
Nov 2008	75	7	68	25	-18	41.0
Oct 2008	77	7	68	25	-18	41.0
Sep 2008	77	16	72	12	+4	52.0
Aug 2008	79	23	68	9	+14	57.0

Imports*

Imports of materials by manufacturers contracted during November as the Imports Index registered 37.5 percent, 3.5 percentage points lower than the 41 percent reported in October. This is the 10th consecutive month of contraction in imports.

The only industry reporting growth in import activity for November is Apparel, Leather & Allied Products. The industries that reported decreases in imports during November are: Nonmetallic Mineral Products; Petroleum & Coal Products; Paper Products; Fabricated Metal Products; Computer & Electronic Products; Plastics & Rubber Products; Electrical Equipment, Appliances & Components; Transportation Equipment; Furniture & Related Products; Primary Metals; Food, Beverage & Tobacco Products; Machinery; Chemical Products; and Miscellaneous Manufacturing.

Imports	% Reporting	% Higher	% Same	% Lower	Net	Index
Nov 2008	83	8	59	33	-25	37.5
Oct 2008	79	8	66	26	-18	41.0
Sep 2008	81	5	78	17	-12	44.0
Aug 2008	82	9	79	12	-3	48.5

* The Backlog of Orders, Prices, Customers' Inventories, Imports and New Export Orders Indexes do not meet the accepted criteria for seasonal adjustments.

Buying Policy

Average commitment lead time for Capital Expenditures decreased 8 days to 106 days. Average lead time for Production Materials is unchanged at 48 days. Average lead time for Maintenance, Repair and Operating (MRO) Supplies decreased 4 days to 21 days.

Percent Reporting							
Capital Expenditures	**Hand-to-Mouth**	**30 Days**	**60 Days**	**90 Days**	**6 Months**	**1 Year+**	**Average Days**
Nov 2008	28	8	11	20	23	10	106
Oct 2008	23	12	12	17	24	12	114
Sep 2008	28	5	14	15	27	11	113
Aug 2008	25	6	16	16	24	13	117
Production Materials	**Hand-to-Mouth**	**30 Days**	**60 Days**	**90 Days**	**6 Months**	**1 Year+**	**Average Days**
Nov 2008	24	40	23	7	4	2	48
Oct 2008	27	37	24	6	3	3	48
Sep 2008	26	39	18	10	4	3	51
Aug 2008	23	35	27	6	6	3	55
MRO Supplies	**Hand-to-Mouth**	**30 Days**	**60 Days**	**90 Days**	**6 Months**	**1 Year+**	**Average Days**
Nov 2008	62	26	8	2	2	0	21
Oct 2008	52	36	8	2	1	1	25
Sep 2008	53	37	7	2	1	0	22
Aug 2008	53	34	9	4	0	0	22

About this Report

The data presented herein is obtained from a survey of manufacturing supply managers based on information they have collected within their respective organizations. ISM makes no representation, other than that stated within this release, regarding the individual company data collection procedures. Use of the data is in the public domain and should be compared to all other economic data sources when used in decision-making.

Data and Method of Presentation

The **Manufacturing ISM *Report On Business*®** is based on data compiled from purchasing and supply executives nationwide. Membership of the Manufacturing Business Survey Committee is diversified by NAICS, based on each industry's contribution to gross domestic product (GDP).

Manufacturing Business Survey Committee responses are divided into the following NAICS code categories: Food, Beverage & Tobacco Products; Textile Mills; Apparel, Leather & Allied Products; Wood Products; Paper Products; Printing & Related Support Activities; Petroleum & Coal Products; Chemical Products; Plastics & Rubber Products; Nonmetallic Mineral Products; Primary Metals; Fabricated Metal Products; Machinery; Computer & Electronic Products; Electrical Equipment, Appliances & Components; Transportation Equipment; Furniture & Related Products; and Miscellaneous Manufacturing (products such as medical equipment and supplies, jewelry, sporting goods, toys and office supplies).

Survey responses reflect the change, if any, in the current month compared to the previous month. For each of the indicators measured (New Orders, Backlog of Orders, New Export Orders, Imports, Production, Supplier Deliveries, Inventories, Customers' Inventories, Employment and Prices), this report shows the percentage reporting each response, the net difference between the number of responses in the positive economic direction (higher, better and slower for Supplier Deliveries) and the negative economic direction (lower, worse and faster for Supplier Deliveries), and the diffusion index. Responses are raw data and are never changed. The diffusion index includes the percent of positive responses plus one-half of those responding the same (considered positive).

The resulting single index number for those meeting the criteria for seasonal adjustments (PMI, New Orders, Production, Employment, Supplier Deliveries and Inventories) is then seasonally adjusted to allow for the effects of repetitive intra-year variations resulting primarily from normal differences in weather conditions, various institutional arrangements, and differences attributable to non-moveable holidays. All seasonal adjustment factors are supplied by the U.S. Department of Commerce and are subject annually to relatively minor changes when conditions warrant them. The PMI is a composite index based on the seasonally adjusted diffusion indexes for five of the indicators with equal weights: New Orders, Production, Employment, Supplier Deliveries and Inventories.

Diffusion indexes have the properties of leading indicators and are convenient summary measures showing the prevailing direction of change and the scope of change. A PMI reading above 50 percent indicates that the manufacturing economy is generally expanding; below 50 percent indicates that it is generally declining. A PMI in excess of 41.1 percent, over a period of time, indicates that the overall economy, or gross domestic product (GDP), is generally expanding; below 41.1 percent, it is generally declining. The distance from 50 percent or 41.1 percent is indicative of the strength of the expansion or decline. With some of the indicators within this report, ISM has indicated the departure point between expansion and decline of comparable government series, as determined by regression analysis.

Responses to Buying Policy reflect the percent reporting the current month's lead time, the approximate weighted number of days ahead for which commitments are made for Production Materials; Capital Expenditures; and Maintenance, Repair and Operating (MRO) Supplies, expressed as hand-to-mouth (five days), 30 days, 60 days, 90 days, six months (180 days), a year or more (360 days), and the weighted average number of days. These responses are raw data, never revised, and not seasonally adjusted since there is no significant seasonal pattern.

The **Manufacturing ISM *Report On Business*®** is published monthly by the Institute for Supply Management™. The Institute for Supply Management™, established in 1915, is the largest supply management organization in the world as well as one of the most respected. ISM's mission is to lead the supply management profession through its standards of excellence, research, promotional activities and education. This report has been issued by the association since 1931, except for a four-year interruption during World War II.

NACFAM
National Council for Advanced Manufacturing
"Strategies for a New Industrial Era"

Volume 7, Issue 1

March 2008

Manufacturing Metrics

Key Points

- Mfg employment declines continue; Led by "white collar" losses
- Durable manufacturing reports record profits; Nondurable manufacturing declines 37%
- ISM new orders index negative; continuing decline of new orders for manufactured goods
- Mfg output and capacity utilization holds steady
- PPI at 7.4%; Core CPI at 4.2% for January
- U.S. exports to China show strong increases; Overall trade deficit holds

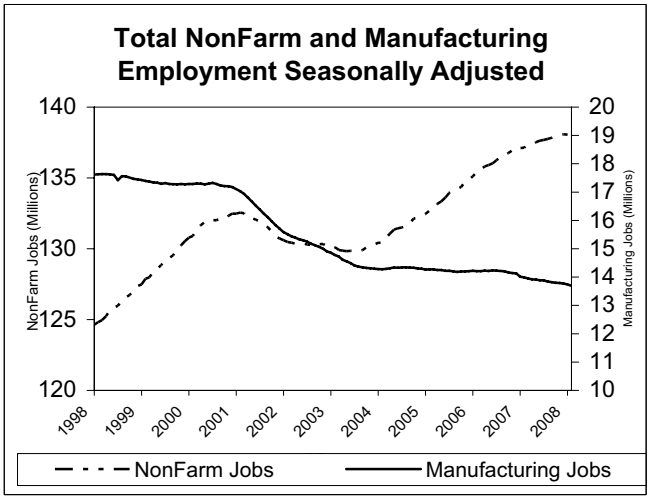

Figure 1

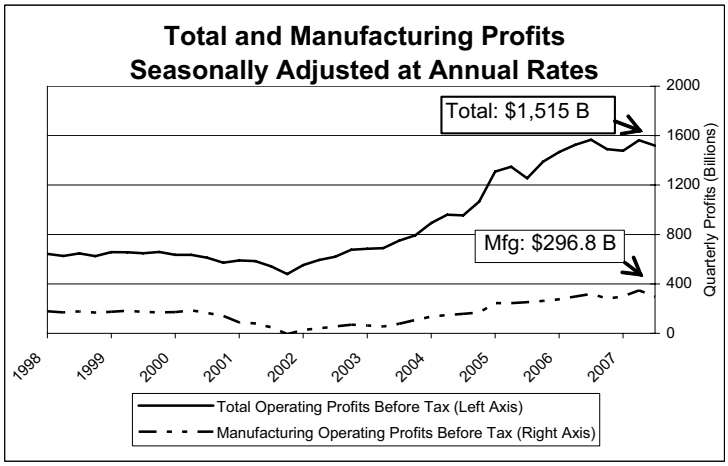

Figure 2

Manufacturing employment declines continue; Led by "white collar" losses

Seasonally adjusted manufacturing employment was reported at 13.7 million by the Bureau of Labor Statistics reported on March 7. Manufacturing employment continued its slow decline in February (down 52,000) and the industry has lost 299,000 or 2.1% over the past year (**Figure 1**).

Within durable goods, total employment declined 40,000 in February. During the past year, production worker employment decreased 121,000 (2.0%) as compared to 82,000 (3.3%) for non-production "white collar" employment in durable goods. Since 2004, durable goods losses have been lead by "white collar" jobs losses (9.7%) as compared to 1.4% "blue collar" jobs gains. Since 1998, the durable goods sector has lost 20.5% in both white and blue collar jobs.

Durable manufacturing reports record profits; Nondurable manufacturing declines 37%

Third quarter 2007 manufacturing profits fell to $50 B (17%) as compared to record highs set in the second quarter 2007 as reported by the Bureau of Economic Analysis in February. Total corporate profits with inventory valuation and capital consumption adjustments were down 3% 1,515 B. **(Figure 2)**

Durable goods profits set a fifth consecutive quarterly record at $128.5 B, up 10% over the previous quarter. Nondurable goods profits fell $44 B, or 37%, from the record setting second quarter 2007.

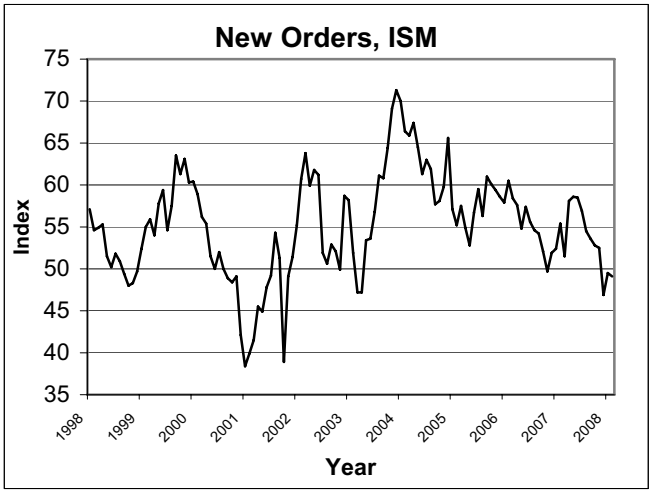

Figure 3

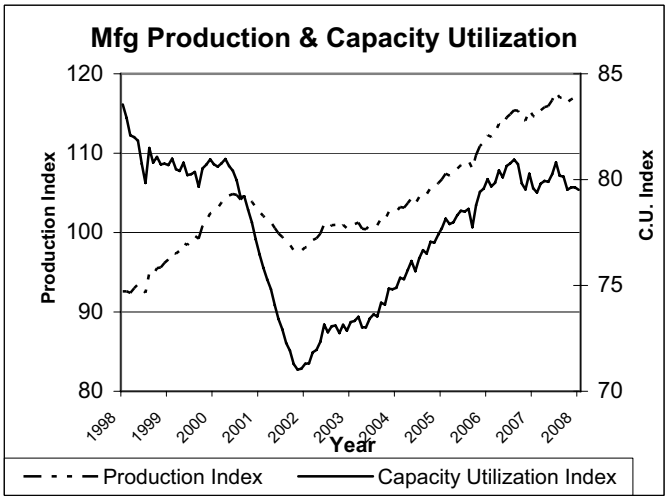

Figure 4

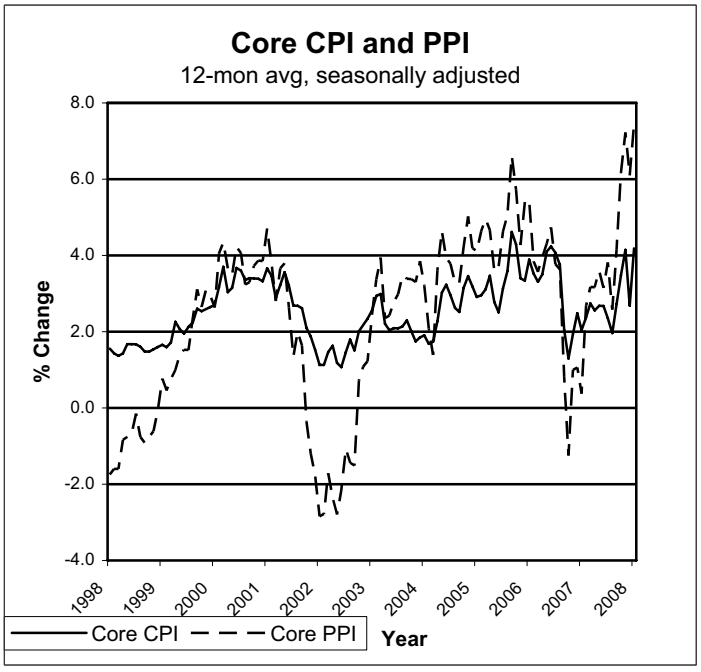

Figure 5

ISM new orders index negative; continuing decline of new orders for manufactured goods

According to the Institute for Supply Management, the New Orders Index declined in February with a reading of 49.1. The index has continued down eight out of the last nine months. The index has indicated decreasing orders for the past three months. **(Figure 3)**

ISM also reported "manufacturers' order backlogs continue to erode...with the Inventories and Customer Inventories Indexes indicating that manufacturing inventories are at reasonable levels, the major concern is rising prices and falling volume:

Manufacturing production output and capacity utilization holds steady

Manufacturing production held steady in January with a year-over-year increase of 2%. The capacity utilization also held steady at 79.5 according to Federal Reserve data released February 15th. Since the beginning of 2006, the capacity utilization index has averaged a very healthy 80. **(Figure 4)**

PPI at 7.4 percent; Core CPI at 4.2 percent for January

PPI for finished goods increased 0.6% to 167.6 in January, seasonally adjusted, reported the Bureau of Labor Statistics in January. The 12-month moving average PPI gained 7.4%. The CPI(U) had a one month increase of 1.8% in January while the 12-month moving average CPI (U) increased 4.2%.**(Figure 5)**

Figure 6

U.S. exports to China show strong increases; Overall trade deficit holds

In 2007, U.S. exports to China increased 18.1% over 2006 ($10 B) while imports increased 11.7% ($33.7 B). The goods deficit with China averaged nearly $256 billion for the past 12 months, resulting in a 0.6% trade gap increase.

Overall, the U.S. trade deficit increased 0.2% over last year. The U.S. total goods deficit for the past 12 months averaged $790 billion, slightly down from the previous month. **(Figure 6)**

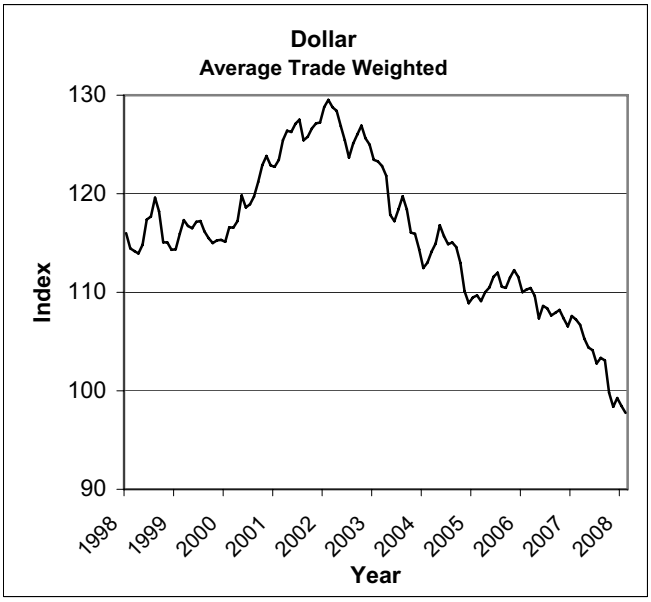

Figure 7

Trade-weighted dollar continues decline

In February, the Federal Reserve's trade-weighted broad dollar index declined to 97.75 for a 10.1 percent decline since the start of 2007. The dollar continues to fall compared to its peak at 129.52 (down 32.5%) in February 2002.
(Figure 7)

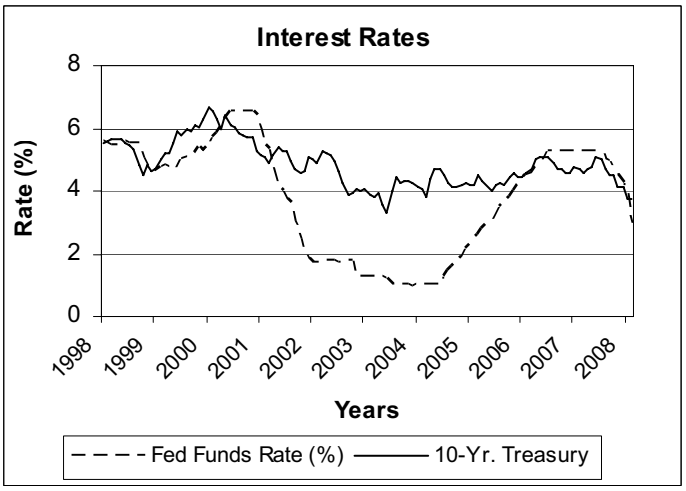

Figure 8

The Federal Reserve cuts rates to 2.98 percent; 10 Year Treasury bills decline to 3.74 percent

In response to tightening financial markets, the Federal Open Market Committee cut the Federal Funds rate to 2.98 percent, lowest since 2004. The 10-year treasury bill continued to fall in February to 3.74 percent. **(Figure 8)**

Global Trends 2025:
A Transformed World

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Global Trends 2025:
A Transformed World

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We prepared ***Global Trends 2025: A Transformed World*** to stimulate strategic thinking about the future by identifying key trends, the factors that drive them, where they seem to be headed, and how they might interact. It uses scenarios to illustrate some of the many ways in which the drivers examined in the study (e.g., globalization, demography, the rise of new powers, the decay of international institutions, climate change, and the geopolitics of energy) may interact to generate challenges and opportunities for future decisionmakers. The study as a whole is more a description of the factors likely to shape events than a prediction of what will actually happen.

By examining a small number of variables that we judge probably will have a disproportionate influence on future events and possibilities, the study seeks to help readers to recognize signposts indicating where events are headed and to identify opportunities for policy intervention to change or lock in the trajectories of specific developments. Among the messages we hope to convey are: "If you like where events seem to be headed, you may want to take timely action to preserve their positive trajectory. If you do not like where they appear to be going, you will have to develop and implement policies to change their trajectory." For example, the report's examination of the transition out of dependence on fossil fuels illustrates how different trajectories will entail different consequences for specific countries. An even more important message is that leadership matters, no trends are immutable, and that timely and well-informed intervention can decrease the likelihood and severity of negative developments and increase the likelihood of positive ones.

Global Trends 2025 is the fourth installment in the National Intelligence Council-led effort to identify key drivers and developments likely to shape world events a decade or more in the future. Both the product and the process used to produce it benefited from lessons learned in previous iterations. Each edition of ***Global Trends*** has tapped larger and more diverse communities of experts. Our first effort, which looked out to 2010, relied primarily on expertise within the US Intelligence Community. There was some outreach to other elements of the United States Government and the American academic community. For ***Global Trends 2015***, we engaged more numerous and more varied groups of non-US Government experts, most of whom were American citizens.

For the third iteration, ***Global Trends*** **2020,** we greatly expanded the participation of non-American specialists by convening six seminars on five continents. We also increased the number and varied the format of meetings in the United States. These sessions enhanced our understanding of both specific trends and drivers and the ways these factors were perceived by experts in different regions of the world.

Each past iteration produced an even more interesting and influential report. Indeed, the worldwide response to ***Global Trends 2020*** was extraordinary. The report has been translated into several languages, debated in government offices, discussed in university courses, and used as a point of departure in community meetings on international affairs. The report was closely read and constructively criticized by myriad experts and members of the public.

Seeking to capitalize on the interest generated by previous reports and to capture even wider circles of expertise, we modified our processes yet again to produce ***Global Trends 2025***. In addition to increasing still more the participation of non-USG experts from the United States and abroad to develop the framework for the current study, we shared several drafts with participants via the Internet and a series of discussion sessions across the US and in several other countries. This iteration of ***Global Trends*** is the most collaborative yet produced; that collaboration has made it a better product and we are extremely grateful for the time and intellectual energy that literally hundreds of people have devoted to this effort.

As was the case with our previous looks at global trends that will shape the future, the process and spin-off benefits of preparing ***Global Trends 2025*** were as important as the final product. The ideas generated and insights gained during the preparation of the accompanying report have enriched the work of countless analysts and been incorporated into numerous analytic products published by the National Intelligence Council and other Intelligence Community agencies. Anecdotal evidence indicates they have also influenced the thinking and work of many participants in the process who do not work for the United States Government. We are pleased by and proud of these ancillary benefits and look forward to reaping many more when others have a chance to read and react to this edition of ***Global Trends***.

Many people contributed to the preparation of ***Global Trends 2025***, but no one contributed more than did Mathew Burrows. His intellectual gifts and managerial abilities were critical to the production of this report and everyone involved owes him a huge debt of gratitude. Mat's own note of appreciation on the following page lists others who made especially noteworthy contributions. Many others also made important contributions. We could not have produced this edition of ***Global Trends*** without the support of everyone who participated and we are deeply grateful for the partnerships and the friendships that facilitated and resulted from this collaborative effort.

C. Thomas Fingar
Chairman, National Intelligence Council

Acknowledgements

In preparing this work the National Intelligence Council received immeasurable help from numerous think tanks, consulting firms, academic institutions, and literally hundreds of experts inside and outside governments here in the United States and overseas. We cannot possibly name all the institutions and individuals we consulted but would like to acknowledge a number for their important contributions.

The Atlantic Council of the United States and the Stimson Center were both important for opening doors to institutions abroad and viewpoints that we would not easily have gathered for this project. Dr. William Ralston, Dr. Nick Evans and their team at SRI Consulting Business Intelligence provided needed S & T expertise and guidance. Dr. Alexander Van de Putte of PFC Energy International put together a series of meetings in three regional hubs across the globe to help us begin the process of conceiving and constructing the scenarios. Others involved in that effort include Professor Jean-Pierre Lehmann of the Evian Group at IMD in Lausanne and Peter Schwartz and Doug Randall at the Monitor Group's Global Business Network in San Francisco. Professor Barry Hughes of the University of Denver contributed notably in the scenario construction process and in plotting out the possible trajectories of major powers. Dr. Jacqueline Newmyer and Dr. Stephen Rosen from the Long Term Strategy Group organized three workshops that were critical to advancing our thinking on the complexities of the future security environment and the changing character of conflict. Several individuals and institutions helped organize roundtables to critique drafts or delve deeply into various aspects, including Dr. Geoff Dabelko at the Wilson Center; Dr. Greg Treverton of RAND; Sebastian Mallaby at the Council on Foreign Relations; Carlos Pascual at Brookings; Dr. Michael Auslin at AEI; Professor Christopher Layne at Texas A&M University; Professor Sumit Ganguly at Indiana University and Dr. Robin Niblett and Jonathan Paris at Chatham House in London. Professor John Ikenberry from Princeton's Woodrow Wilson School organized several workshops of prominent international relations scholars, helping us with changing geopolitical trends. Two workshops—one organized by Professor Lanxin Xiang and hosted by CICIR in Beijing, the other organized and hosted by Dr. Bates Gill at SIPRI in Stockholm—were particularly instrumental in gathering international perspectives on strategic challenges facing the world.

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Contents

Textboxes:

The 2025 Global Landscape

Relative Certainties	Likely Impact
A global multipolar system is emerging with the rise of China, India, and others. The relative power of nonstate actors—businesses, tribes, religious organizations, and even criminal networks—also will increase.	By 2025 a single "international community" composed of nation-states will no longer exist. Power will be more dispersed with the newer players bringing new rules of the game while risks will increase that the traditional Western alliances will weaken. Rather than emulating Western models of political and economic development, more countries may be attracted to China's alternative development model.
The unprecedented shift in relative wealth and economic power roughly from West to East now under way will continue.	As some countries become more invested in their economic well-being, incentives toward geopolitical stability could increase. However, the transfer is strengthening states like Russia that want to challenge the Western order.
The United States will remain the single most powerful country but will be less dominant.	Shrinking economic and military capabilities may force the US into a difficult set of tradeoffs between domestic versus foreign policy priorities.
Continued economic growth—coupled with 1.2 billion more people by 2025—will put pressure on energy, food, and water resources.	The pace of technological innovation will be key to outcomes during this period. All current technologies are inadequate for replacing traditional energy architecture on the scale needed.
The number of countries with youthful populations in the "arc of instability"[1] will decrease, but the populations of several youth-bulge states are projected to remain on rapid growth trajectories.	Unless employment conditions change dramatically in parlous youth-bulge states such as Afghanistan, Nigeria, Pakistan, and Yemen, these countries will remain ripe for continued instability and state failure.
The potential for conflict will increase owing to rapid changes in parts of the greater Middle East and the spread of lethal capabilities.	The need for the US to act as regional balancer in the Middle East will increase, although other outside powers—Russia, China and India—will play greater roles than today.
Terrorism is unlikely to disappear by 2025, but its appeal could lessen if economic growth continues in the Middle East and youth unemployment is reduced. For those terrorists that are active the diffusion of technologies will put dangerous capabilities within their reach.	Opportunities for mass-casualty terrorist attacks using chemical, biological, or less likely, nuclear weapons will increase as technology diffuses and nuclear power (and possibly weapons) programs expand. The practical and psychological consequences of such attacks will intensify in an increasingly globalized world.

[1] Countries with youthful age structures and rapidly growing populations mark a crescent or "arc of instability" stretching from the Andean region of Latin America across Sub-Saharan Africa, the Middle East and the Caucasus, and through the northern parts of South Asia.

Key Uncertainties	Potential Consequences
Whether an energy transition away from oil and gas—supported by improved energy storage, biofuels, and clean coal—is completed during the 2025 time frame.	With high oil and gas prices, major exporters such as Russia and Iran will substantially augment their levels of national power, with Russia's GDP potentially approaching that of the UK and France. A sustained plunge in prices, perhaps underpinned by a fundamental switch to new energy sources, could trigger a long-term decline for producers as global and regional players.
How quickly climate change occurs and the locations where its impact is most pronounced.	Climate change is likely to exacerbate resource scarcities, particularly water scarcities.
Whether mercantilism stages a comeback and global markets recede.	Descending into a world of resource nationalism increases the risk of great power confrontations.
Whether advances toward democracy occur in China and Russia.	Political pluralism seems less likely in Russia in the absence of economic diversification. A growing middle class increases the chances of political liberalization and potentially greater nationalism in China.
Whether regional fears about a nuclear-armed Iran trigger an arms race and greater militarization.	Episodes of low-intensity conflict and terrorism taking place under a nuclear umbrella could lead to an unintended escalation and broader conflict.
Whether the greater Middle East becomes more stable, especially whether Iraq stabilizes, and whether the Arab-Israeli conflict is resolved peacefully.	Turbulence is likely to increase under most scenarios. Revival of economic growth, a more prosperous Iraq, and resolution of the Israeli-Palestinian dispute could engender some stability as the region deals with a strengthening Iran and global transition away from oil and gas.
Whether Europe and Japan overcome economic and social challenges caused or compounded by demography.	Successful integration of Muslim minorities in Europe could expand the size of the productive work forces and avert social crisis. Lack of efforts by Europe and Japan to mitigate demographic challenges could lead to long-term declines.
Whether global powers work with multilateral institutions to adapt their structure and performance to the transformed geopolitical landscape.	Emerging powers show ambivalence toward global institutions like the UN and IMF, but this could change as they become bigger players on the global stage. Asian integration could lead to more powerful regional institutions. NATO faces stiff challenges in meeting growing out-of-area responsibilities with declining European military capabilities. Traditional alliances will weaken.

Executive Summary

The **international system**—as constructed following the Second World War—will be almost unrecognizable by 2025 owing to the rise of emerging powers, a globalizing economy, an historic transfer of relative wealth and economic power from West to East, and the growing influence of nonstate actors. By 2025, the international system will be a **global multipolar one** with gaps in national power[2] continuing to narrow between developed and developing countries. Concurrent with the shift in power among nation-states, the relative power of various nonstate actors—including businesses, tribes, religious organizations, and criminal networks—is increasing. The players are changing, but so too are the scope and breadth of transnational issues important for continued global prosperity. Aging populations in the developed world; growing energy, food, and water constraints; and worries about climate change will limit and diminish what will still be an historically unprecedented age of prosperity.

Historically, emerging multipolar systems have been more unstable than bipolar or unipolar ones. Despite the recent financial volatility—which could end up accelerating many ongoing trends—we do not believe that we are headed toward a complete breakdown of the international system, as occurred in 1914-1918 when an earlier phase of globalization came to a halt. However, the next 20 years of transition to a new system are fraught with risks. Strategic rivalries are most likely to revolve around trade, investments, and technological innovation and acquisition, but we cannot rule out a 19th century-like scenario of arms races, territorial expansion, and military rivalries.

This is a story with **no clear outcome,** as illustrated by a series of vignettes we use to map out divergent futures. Although the United States is likely to remain the single most powerful actor, the United States' relative strength—even in the military realm—will decline and US leverage will become more constrained. At the same time, the extent to which other actors—both state and nonstate—will be willing or able to shoulder increased burdens is unclear. Policymakers and publics will have to cope with a growing demand for multilateral cooperation when the international system will be stressed by the incomplete transition from the old to a still-forming new order.

Economic Growth Fueling Rise of Emerging Players

In terms of size, speed, and directional flow, the transfer of **global wealth and economic power** now under way—roughly from West to East—is without precedent in modern history. This shift derives from two sources. First, increases in oil and commodity prices have generated windfall profits for the Gulf states and Russia. Second, lower costs combined with government policies have shifted the locus of manufacturing and some service industries to Asia.

Growth projections for Brazil, Russia, India, and China (the BRICs) indicate they will collectively match the original G-7's share of global GDP by 2040-2050. **China** is poised to have more impact on the world over the next 20 years than any other country. If current trends persist, by 2025 China will have the world's second largest economy and will be a leading

[2] National power scores, computed by the International Futures computer model, are the product of an index combining the weighted factors of GDP, defense spending, population, and technology.

military power. It also could be the largest importer of natural resources and the biggest polluter. **India** probably will continue to enjoy relatively rapid economic growth and will strive for a multipolar world in which New Delhi is one of the poles. China and India must decide the extent to which they are willing and capable of playing increasing global roles and how each will relate to the other. **Russia** has the potential to be richer, more powerful, and more self-assured in 2025 if it invests in human capital, expands and diversifies its economy, and integrates with global markets. On the other hand, Russia could experience a significant decline if it fails to take these steps and oil and gas prices remain in the $50-70 per barrel range. No other countries are projected to rise to the level of China, India, or Russia, and none is likely to match their individual global clout. We expect, however, to see the political and economic power of other countries—such as Indonesia, Iran, and Turkey—increase.

For the most part, China, India, and Russia are not following the Western liberal model for self-development but instead are using a different model, "**state capitalism**." State capitalism is a loose term used to describe a system of economic management that gives a prominent role to the state. Other rising powers—South Korea, Taiwan, and Singapore—also used state capitalism to develop their economies. However, the impact of Russia, and particularly China, following this path is potentially much greater owing to their size and approach to "democratization." We remain optimistic about the *long-term* prospects for **greater democratization**, even though advances are likely to be slow and globalization is subjecting many recently democratized countries to increasing social and economic pressures with the potential to undermine liberal institutions.

Many other countries will fall further behind economically. **Sub-Saharan Africa** will remain the region most vulnerable to economic disruption, population stresses, civil conflict, and political instability. Despite increased global demand for commodities for which Sub-Saharan Africa will be a major supplier, local populations are unlikely to experience significant economic gain. Windfall profits arising from sustained increases in commodity prices might further entrench corrupt or otherwise ill-equipped governments in several regions, diminishing the prospects for democratic and market-based reforms. Although many of **Latin America's** major countries will have become middle income powers by 2025, others, particularly those such as Venezuela and Bolivia that have embraced populist policies for a protracted period, will lag behind—and some, such as Haiti, will have become even poorer and less governable. Overall, Latin America will continue to lag behind Asia and other fast-growing areas in terms of economic competitiveness.

Asia, Africa, and Latin America will account for virtually all **population growth** over the next 20 years; less than 3 percent of the growth will occur in the West. Europe and Japan will continue to far outdistance the emerging powers of China and India in per capita wealth, but they will struggle to maintain robust growth rates because the size of their working-age populations will decrease. The US will be a partial exception to the aging of populations in the developed world because it will experience higher birth rates and more immigration. The number of migrants seeking to move from disadvantaged to relatively privileged countries is likely to increase.

The number of countries with youthful age structures in the current "arc of instability" is projected to decline by as much as 40 percent. Three of every four youth-bulge countries that remain will be located in Sub-Saharan Africa; nearly all of the remainder will be located in the core of the Middle East, scattered through southern and central Asia, and in the Pacific Islands.

New Transnational Agenda

Resource issues will gain prominence on the international agenda. Unprecedented global economic growth—positive in so many other regards—will continue to put pressure on a number of **highly strategic resources**, including energy, food, and water, and demand is projected to outstrip easily available supplies over the next decade or so. For example, non-OPEC liquid hydrocarbon production—crude oil, natural gas liquids, and unconventionals such as tar sands—will not grow commensurate with demand. Oil and gas production of many traditional energy producers already is declining. Elsewhere—in China, India, and Mexico—production has flattened. Countries capable of significantly expanding production will dwindle; oil and gas production will be concentrated in unstable areas. As a result of this and other factors, the world will be in the midst of a fundamental energy transition away from oil toward natural gas, coal and other alternatives.

The World Bank estimates that **demand for food** will rise by 50 percent by 2030, as a result of growing world population, rising affluence, and the shift to Western dietary preferences by a larger middle class. Lack of access to stable supplies of water is reaching critical proportions, particularly for agricultural purposes, and the problem will worsen because of rapid urbanization worldwide and the roughly 1.2 billion persons to be added over the next 20 years. Today, experts consider 21 countries, with a combined population of about 600 million, to be either cropland or freshwater scarce. Owing to continuing population growth, 36 countries, with about 1.4 billion people, are projected to fall into this category by 2025.

Climate change is expected to exacerbate resource scarcities. Although the impact of climate change will vary by region, a number of regions will begin to suffer harmful effects, particularly water scarcity and loss of agricultural production. Regional differences in agricultural production are likely to become more pronounced over time with declines disproportionately concentrated in developing countries, particularly those in Sub-Saharan Africa. Agricultural losses are expected to mount with substantial impacts forecast by most economists by late this century. For many developing countries, decreased agricultural output will be devastating because agriculture accounts for a large share of their economies and many of their citizens live close to subsistence levels.

New technologies could again provide solutions, such as viable alternatives to fossil fuels or means to overcome food and water constraints. However, all current technologies are inadequate for replacing the traditional energy architecture on the scale needed, and new energy technologies probably will not be commercially viable and widespread by 2025. The pace of technological innovation will be key. Even with a favorable policy and funding environment for biofuels, clean coal, or hydrogen, the transition to new fuels will be slow. Major technologies historically have had an "adoption lag." In the energy sector, a recent study found that it takes an average of 25 years for a new production technology to become widely adopted.

Despite what are seen as long odds now, we cannot rule out the possibility of an **energy transition** by 2025 that would avoid the costs of an energy infrastructure overhaul. The greatest possibility for a relatively quick and inexpensive transition during the period comes from better renewable generation sources (photovoltaic and wind) and improvements in battery technology. With many of these technologies, the infrastructure cost hurdle for individual projects would be lower, enabling many small economic actors to develop their own energy transformation projects that directly serve their interests—e.g., stationary fuel cells powering homes and offices, recharging plug-in hybrid autos, and selling energy back to the grid. Also, energy conversion schemes—such as plans to generate hydrogen for automotive fuel cells from electricity in the homeowner's garage—could avoid the need to develop complex hydrogen transportation infrastructure.

Prospects for Terrorism, Conflict, and Proliferation

Terrorism, proliferation, and conflict will remain key concerns even as resource issues move up on the international agenda. Terrorism is unlikely to disappear by 2025, but its appeal could diminish if economic growth continues and youth unemployment is mitigated in the Middle East. Economic opportunities for youth and greater political pluralism probably would dissuade some from joining terrorists' ranks, but others—motivated by a variety of factors, such as a desire for revenge or to become "martyrs"—will continue to turn to violence to pursue their objectives.

In the absence of employment opportunities and legal means for political expression, conditions will be ripe for disaffection, growing radicalism, and possible recruitment of youths into **terrorist groups.** Terrorist groups in 2025 will likely be a combination of descendants of long-established groups—that inherit organizational structures, command and control processes, and training procedures necessary to conduct sophisticated attacks—and newly emergent collections of the angry and disenfranchised that become self-radicalized. For those terrorist groups that are active in 2025, the diffusion of technologies and scientific knowledge will place some of the world's most dangerous capabilities within their reach. One of our greatest concerns continues to be that terrorist or other malevolent groups might acquire and employ biological agents, or less likely, a nuclear device, to create mass casualties.

Although **Iran's** acquisition of nuclear weapons is not inevitable, other countries' worries about a nuclear-armed Iran could lead states in the region to develop new security arrangements with external powers, acquire additional weapons, and consider pursuing their own nuclear ambitions. It is not clear that the type of stable deterrent relationship that existed between the great powers for most of the Cold War would emerge naturally in the Middle East with a nuclear-weapons capable Iran. Episodes of low-intensity conflict taking place under a nuclear umbrella could lead to an unintended escalation and broader conflict if clear red lines between those states involved are not well established.

We believe **ideological conflicts** akin to the Cold War are unlikely to take root in a world in which most states will be preoccupied with the pragmatic challenges of globalization and shifting global power alignments. The force of ideology is likely to be strongest in the Muslim world—particularly the Arab core. In those countries that are likely to struggle with youth bulges and weak economic underpinnings—such as Pakistan, Afghanistan, Nigeria, and Yemen—the radical Salafi trend of Islam is likely to gain traction.

Types of **conflict** we have not seen for awhile—such as over resources—could reemerge. Perceptions of energy scarcity will drive countries to take actions to assure their future access to energy supplies. In the worst case, this could result in interstate conflicts if government leaders deem assured access to energy resources, for example, to be essential for maintaining domestic stability and the survival of their regimes. However, even actions short of war will have important geopolitical consequences. Maritime security concerns are providing a rationale for naval buildups and modernization efforts, such as China's and India's development of blue-water naval capabilities. The buildup of regional naval capabilities could lead to increased tensions, rivalries, and counterbalancing moves but it also will create opportunities for multinational cooperation in protecting critical sea lanes. With water becoming more scarce in Asia and the Middle East, cooperation to manage changing water resources is likely to become more difficult within and between states.

The risk of **nuclear weapon use** over the next 20 years, although remaining very low, is likely to be greater than it is today as a result of several converging trends. The spread of nuclear technologies and expertise is generating concerns about the potential emergence of new nuclear weapon states and the acquisition of nuclear materials by terrorist groups. Ongoing low-intensity clashes between India and Pakistan continue to raise the specter that such events could escalate to a broader conflict between those nuclear powers. The possibility of a future disruptive regime change or collapse occurring in a nuclear weapon state such as North Korea also continues to raise questions regarding the ability of weak states to control and secure their nuclear arsenals.

If nuclear weapons are used in the next 15-20 years, the international system will be shocked as it experiences immediate humanitarian, economic, and political-military repercussions. A future use of nuclear weapons probably would bring about significant geopolitical changes as some states would seek to establish or reinforce security alliances with existing nuclear powers and others would push for global nuclear disarmament.

A More Complex International System

The trend toward greater diffusion of authority and power that has been occurring for a couple decades is likely to accelerate because of the emergence of new global players, the worsening institutional deficit, potential expansion of regional blocs, and enhanced strength of nonstate actors and networks. The **multiplicity of actors** on the international scene could add strength—in terms of filling gaps left by aging post-World War II institutions—or further fragment the international system and incapacitate international cooperation. The diversity in type of actor raises the likelihood of fragmentation occurring over the next two decades, particularly given the wide array of transnational challenges facing the international community.

The rising BRIC powers are unlikely to challenge the international system as did Germany and Japan in the 19th and 20th centuries, but because of their growing geopolitical and economic clout, they will have a high degree of freedom to customize their political and economic policies rather than fully adopting Western norms. They also are likely to want to preserve their policy freedom to maneuver, allowing others to carry the primary burden for dealing with such issues as terrorism, climate change, proliferation, and energy security.

Existing multilateral institutions—which are large and cumbersome and were designed for a different geopolitical order—will have difficulty adapting quickly to undertake new missions, accommodate changing memberships, and augment their resources.
Nongovernmental organizations (NGOs)—concentrating on specific issues—increasingly will be a part of the landscape, but NGO networks are likely to be limited in their ability to effect change in the absence of concerted efforts by multilateral institutions or governments. Efforts at greater inclusiveness—to reflect the emergence of the newer powers—may make it harder for international organizations to tackle transnational challenges. Respect for the dissenting views of member nations will continue to shape the agenda of organizations and limit the kinds of solutions that can be attempted.

Greater **Asian regionalism**—possible by 2025—would have global implications, sparking or reinforcing a trend toward three trade and financial clusters that could become quasi-blocs: North America, Europe, and East Asia. Establishment of such quasi-blocs would have implications for the ability to achieve future global World Trade Organization (WTO) agreements. Regional clusters could compete in setting trans-regional product standards for information technology, biotechnology, nanotechnology, intellectual property rights, and other aspects of the "new economy." On the other hand, an absence of regional cooperation in Asia could help spur competition among China, India, and Japan over resources such as energy.

Intrinsic to the growing complexity of the overlapping roles of states, institutions, and nonstate actors is the **proliferation of political identities**, which is leading to establishment of new networks and rediscovered communities. No one political identity is likely to be dominant in most societies by 2025. Religion-based networks may be quintessential issue networks and overall may play a more powerful role on many transnational issues such as the environment and inequalities than secular groupings.

The United States: Less Dominant Power
By 2025 the US will find itself as one of a number of important actors on the world stage, albeit still the most powerful one. Even in the military realm, where the US will continue to possess considerable advantages in 2025, advances by others in science and technology, expanded adoption of irregular warfare tactics by both state and nonstate actors, proliferation of long-range precision weapons, and growing use of cyber warfare attacks increasingly will constrict US freedom of action. A more constrained US role has implications for others and the likelihood of new agenda issues being tackled effectively. Despite the recent rise in anti-Americanism, the US probably will continue to be seen as a much-needed regional balancer in the Middle East and Asia. The US will continue to be expected to play a significant role in using its military power to counter global terrorism. On newer security issues like climate change, US leadership will be widely perceived as critical to leveraging competing and divisive views to find solutions. At the same time, the multiplicity of influential actors and distrust of vast power means less room for the US to call the shots without the support of strong partnerships. Developments in the rest of the world, including internal developments in a number of key states—particularly China and Russia—are also likely to be crucial determinants of US policy.

2025—What Kind of Future?

The above trends suggest major **discontinuities**, shocks, and surprises, which we highlight throughout the text. Examples include nuclear weapons use or a pandemic. In some cases, the surprise element is only a matter of **timing**: an energy transition, for example is inevitable; the only questions are when and how abruptly or smoothly such a transition occurs. An energy transition from one type of fuel (fossil fuels) to another (alternative) is an event that historically has only happened once a century at most with momentous consequences. The transition from wood to coal helped trigger industrialization. In this case, a transition—particularly an abrupt one—out of fossil fuels would have major repercussions for energy producers in the Middle East and Eurasia, potentially causing permanent decline of some states as global and regional powers.

Other discontinuities are less predictable. They are likely to result from an interaction of several trends and depend on the quality of leadership. We put uncertainties such as whether China or Russia becomes a democracy in this category. China's growing middle class increases the chances but does not make such a development inevitable. Political pluralism seems less likely in Russia in the absence of economic diversification. Pressure from below may force the issue, or a leader might begin or enhance the democratization process to sustain the economy or spur economic growth. A sustained plunge in the price of oil and gas would alter the outlook and increase prospects for greater political and economic liberalization in Russia. If either country were to democratize, it would represent another wave of democratization with wide significance for many other developing states.

Also **uncertain** are the outcomes of demographic challenges facing Europe, Japan, and even Russia. In none of these cases does demography have to spell destiny with less regional and global power an inevitable outcome. Technology, the role of immigration, public health improvements, and laws encouraging greater female participation in the economy are some of the measures that could change the trajectory of current trends pointing toward less economic growth, increased social tensions, and possible decline.

Whether global institutions adapt and revive—another key uncertainty—also is a function of leadership. Current trends suggest a dispersion of power and authority will create a global governance deficit. Reversing those trend lines would require strong leadership in the international community by a number of powers, including the emerging ones.

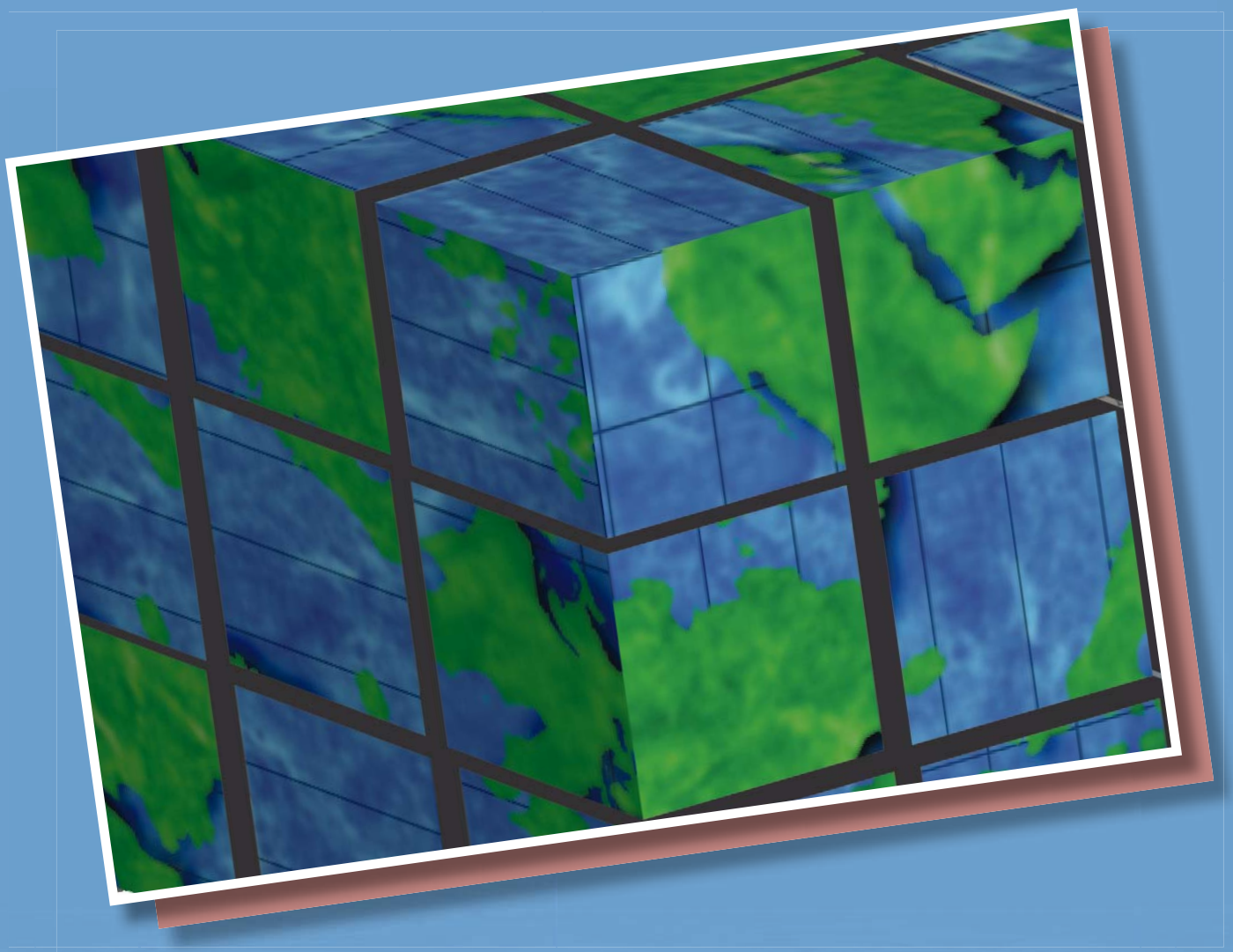
Some uncertainties would have greater consequences—should they occur—than would others. In this work, we emphasize the overall potential for greater conflict—some forms of which could threaten globalization. We put WMD terrorism and a Middle East nuclear arms race in this category. The key uncertainties and possible impacts are discussed in the text and summarized in the textbox on page vii. In the four fictionalized scenarios, we have highlighted new challenges that could emerge as a result of the ongoing global transformation. They present new situations, dilemmas, or predicaments that represent departures from recent developments. As a set, they do not cover all possible futures. ***None of these is inevitable or even necessarily likely***; but, as with many other uncertainties, the scenarios are potential game-changers.

- In ***A World Without the West***, the new powers supplant the West as the leaders on the world stage.

- ***October Surprise*** illustrates the impact of inattention to global climate change; unexpected major impacts narrow the world's range of options.

- In ***BRICs' Bust-Up***, disputes over vital resources emerge as a source of conflict between major powers—in this case two emerging heavyweights—India and China.

- In ***Politics is Not Always Local,*** nonstate networks emerge to set the international agenda on the environment, eclipsing governments.



Introduction

A Transformed World

The international system—as constructed following the Second World War—will be almost unrecognizable by 2025. Indeed, "international system" is a misnomer as it is likely to be more ramshackle than orderly, its composition hybrid and heterogeneous as befits a transition that will still be a work in progress in 2025. The transformation is being fueled by a globalizing economy, marked by an historic shift of relative wealth and economic power from West to East, and by the increasing weight of new players—especially China and India. The US will remain the single most important actor but will be less dominant. As was true of the United States in the 19th and 20th centuries, China and India will at times be reticent and at other times impatient to assume larger roles on the world stage. In 2025, both will still be more concerned about their own internal development than changing the international system.

Concurrent with the shift in power among nation-states, the ***relative*** power of various nonstate actors—including businesses, tribes, religious organizations, and even criminal networks—will continue to increase. Several countries could even be "taken over" and run by criminal networks. In areas of Africa or South Asia, states as we know them might wither away, owing to the inability of governments to provide for basic needs, including security.

By 2025, the international community will be composed of many actors in addition to nation-states and will lack an overarching approach to global governance. The "system" will be multipolar with many clusters of both state and nonstate actors. Multipolar international systems—like the Concert of Europe—have existed in the past, but the one that is emerging is unprecedented because it is global and encompasses a mix of state and nonstate actors that are not grouped into rival camps of roughly equal weight. The most salient characteristics of the "new order" will be the shift from a unipolar world dominated by the United States to a relatively unstructured hierarchy of old powers and rising nations, and the diffusion of power from state to nonstate actors.

"…we do not believe that we are headed toward a complete breakdown [of the international system]…However, the next 20 years of transition toward a new international system are fraught with risks…"

History tells us that rapid change brings many dangers. Despite the recent financial volatility, which could end up accelerating many ongoing trends, we do not believe that we are headed toward a complete breakdown—as occurred in 1914-1918 when an earlier phase of globalization came to a halt. However, the next 20 years of transition toward a new international system are fraught with risks—more than we envisaged when we published ***Mapping the Global Future***[3] in 2004. These risks include the growing prospect of a nuclear arms race in the Middle East and possible interstate conflicts over resources. The breadth of transnational issues requiring attention also is increasing to include issues connected with resource constraints in energy, food, and water; and worries about climate change. Global institutions that could help the world deal with these transnational issues and, more generally, mitigate the risks of rapid change currently appear incapable of rising to the

[3] See ***Mapping the Global Future: Report of the National Intelligence Council's 2020 Project***, National Intelligence Council, December 2004, which can be found at: www.dni.gov/nic/NIC_2020_project.html.

Comparison Between *Mapping the Global Future: Report of the Intelligence Council's 2020 Project* and *Global Trends 2025: A Transformed World*

The most dramatic difference between ***Mapping the Global Future: Report of the Intelligence Council's 2020 Project*** and ***Global Trends 2025: A Transformed World*** is the latter's assumptions of a multipolar future, and therefore dramatic changes in the international system. The 2025 report describes a world in which the US plays a prominent role in global events, but the US is one among many global actors who manage problems. In contrast, the 2020 report projects continued US dominance, positing that most major powers have forsaken the idea of balancing the US.

The two documents also differ in their treatment of energy supply, demand, and new alternative sources. In 2020, energy supplies "in the ground" are considered "sufficient to meet global demand." What is uncertain, according to the earlier report, is whether political instability in producer countries, supply disruptions, or competition for resources might deleteriously affect international oil markets. Though 2020 mentions the global increase in energy consumption, it emphasizes the domination of fossil fuels. In contrast, 2025 sees the world in the midst of a transition to cleaner fuels. New technologies are projected to provide the capability for fossil fuel substitutes and solutions to water and food scarcity. The 2020 report acknowledges that energy demands will influence superpower relations, but the 2025 report considers energy scarcity as a driving factor in geopolitics.

Both reports project probable strong global economic growth—fueled by the rise of Brazil, Russia, India, and China, absent major shocks. The 2025 report, however, assesses the likelihood of major discontinuities to be high, emphasizing that "no single outcome seems preordained" and that the next 20 years of transition toward a new international system are fraught with risks, such as a nuclear arms race in the Middle East and possible interstate conflicts over resources.

The scenarios in both reports address the future of globalization, the future structure of the international system, and the dividing lines among groups that will cause conflict or convergence. In both reports, globalization is seen as a driver so pervasive that it will reorder current divisions based on geography, ethnicity, and religious and socio-economic status.

challenges without concerted efforts by their leaders.

More Change than Continuity

The rapidly changing international order at a time of growing geopolitical challenges increases the likelihood of discontinuities, shocks, and surprises. No single outcome seems preordained: the Western model of economic liberalism, democracy, and secularism, for example, which many assumed to be inevitable, may lose its luster—at least in the medium term.

In some cases, the surprise element is only a matter of timing: an energy transition, for example, is inevitable; the only questions are when and how abruptly or smoothly such a transition occurs. Other discontinuities are less predictable. Recognizing that what may seem implausible today could become feasible or even likely by 2025, we have looked at a number of single development "shocks." Examples include the global impact of a nuclear arms exchange, a rapid replacement for fossil fuels, and a "democratic" China.

New technologies could provide solutions, such as viable alternatives to fossil fuel or means to overcome food and water constraints. A critical uncertainty is whether new technologies will be developed and commercialized in time to avert a significant slowdown in economic growth owing to resource constraints. Such a slowdown would jeopardize the rise of new powers and deal a serious blow to the aspirations of those countries not yet fully in the globalization game. A world in which shortages predominate could trigger behaviors different from one in which scarcities are overcome through technology or other means.

Alternative Futures

This study is organized into seven sections that examine:

- The Globalizing Economy.
- Demographics of Discord.
- The New Players.
- Scarcity in the Midst of Plenty.
- Growing Potential for Conflict.
- Will the International System Be Up to the Challenges?
- Power-Sharing in a Multipolar World.

As with our previous works, we will describe possible alternative futures that could result from the trends we discuss.[4] We see the next 15-20 years as one of those great historical turning points where multiple factors are likely to be in play. How such factors intersect with one another and the role of leadership will be crucial to the outcome.

In constructing these scenarios, we focused on critical uncertainties regarding the relative importance of the nation-state as compared with nonstate actors, and the level of global cooperation. In some of the scenarios, states are more dominant and drive global dynamics; in others, nonstate actors, including religious movements, nongovernmental organizations (NGOs), and super-empowered

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[4] See ***Global Trends 2015***, ***A Dialogue About the Future with Nongovernment Experts,*** National Intelligence Council, December 2000; and ***Mapping the Global Future: Report of the National Intelligence Council's 2020 Project***, National Intelligence Council, December 2004. The reports can be found at www.dni.gov/nic/NIC_global trends 2015.html and www.dni.gov/nic/NIC_2020_project.html respectively.

individuals play more important roles. In some of the scenarios, key players interact in competing groups, through partnerships and cross-border affiliations. Other scenarios envision more interaction as autonomous players operate independently and sometimes conflict with one another.

In all the ***fictionalized scenarios***, we highlight challenges that could emerge as a result of the ongoing global transformation. The scenarios present new situations, dilemmas, or predicaments that would cause upheavals in the global landscape, leading to very different "worlds." ***None of these is inevitable or even necessarily likely***; but, as with many other uncertainties, they are potential game-changers.

A World Without the West. In this world, described in a fictional letter from a future head of the Shanghai Cooperation Organization (SCO), new powers supplant the West as the leaders on the world stage. The US feels overburdened and withdraws from Central Asia, including Afghanistan; Europe will not step up to the plate and take the lead. Russia, China, and others are forced to deal with the potential for spillover and instability in Central Asia. The SCO gains ascendance while NATO's status declines. Anti-China antagonism in the US and Europe reaches a crescendo; protectionist trade barriers are put in place. Russia and China enter a marriage of convenience; other countries—India and Iran—rally around them. The lack of any stable bloc—whether in the West or the non-Western world—adds to growing instability and disorder, potentially threatening globalization.

October Surprise. In this world, depicted in a diary entry of a future US President, many countries have been preoccupied with achieving economic growth at the expense of safeguarding the environment. The scientific community has not been able to issue specific warnings, but worries increase that a tipping point has been reached in which climate change has accelerated and possible impacts will be very destructive. New York City is hit by a major hurricane linked to global climate change; the NY Stock Exchange is severely damaged and, in the face of such destruction, world leaders must begin to think about taking drastic measures, such as relocating parts of coastal cities.

BRICs' Bust-Up. In this world, conflict breaks out between China and India over access to vital resources. Outside powers intervene before the conflict escalates and expands into a global conflagration. The clash is triggered by Chinese suspicion of efforts by others to threaten Beijing's energy supplies. Misperceptions and miscalculations lead to the clash. The scenario highlights the importance of energy and other resources to continued growth and development as a great power. It shows the extent to which conflict in a multipolar world is just as likely to occur between rising states as between older and newer powers.

Politics is Not Always Local. In this world, outlined in an article by a fictional ***Financial Times*** reporter, various nonstate networks—NGOs, religious groups, business leaders, and local activists—combine to set the international agenda on the environment and use their clout to elect the UN Secretary General. The global political coalition of nonstate actors plays a crucial role in securing a new worldwide climate change agreement. In this new connected world of digital communications, growing middle classes, and transnational interest groups, politics is no longer local and domestic and international agendas become increasingly interchangeable.

Long-Range Projections: A Cautionary Tale

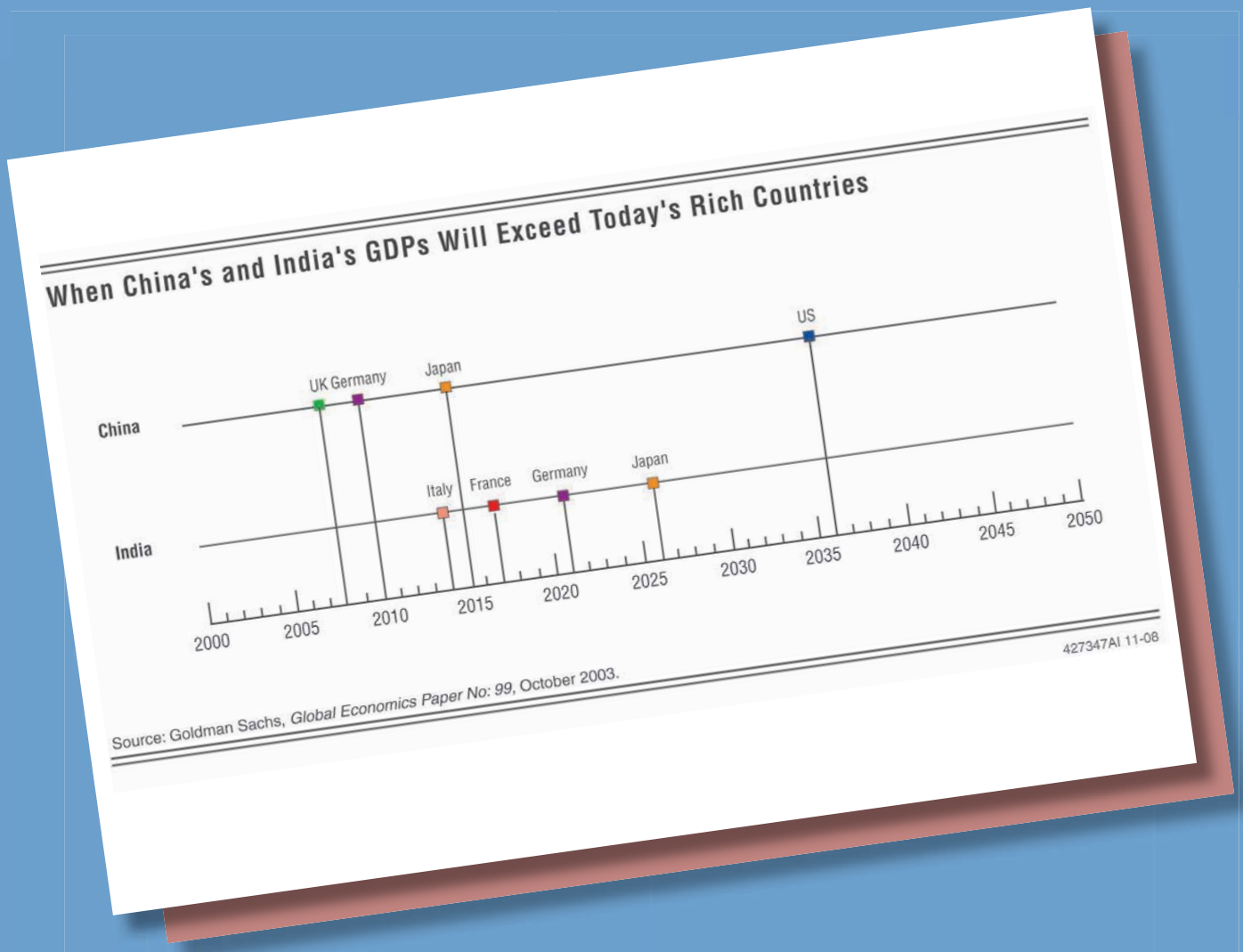
In the 20th century, experts forecasting the next 20 years—roughly the time frame of this study—often missed major geopolitical events, basing their predictions largely on linear projections without exploring possibilities that could cause discontinuities. Before WW I, while tensions between European "great powers" were on the rise, few had an inkling of major changes in the offing, from the extent of mutual slaughter to the downfall of age-old empires. In the early 1920s, few envisioned the lethal situation about to unfold, ushered in by the Great Depression, Stalin's gulags, and an even more bloody world war encompassing multiple genocides. The postwar period saw the establishment of a new international system—many of whose institutions—the UN and Bretton Woods—remain with us. Although the bipolar and nuclear age did not lack war and conflict, it did provide a stable framework until the collapse of the Soviet Union. The development of a globalized economy in which China and India play major roles has opened a new era without clear outcomes.

Lessons from the last century, however, appear to suggest:

- **Leaders and their ideas matter**. No history of the past hundred years can be told without delving into the roles and thinking of such leaders as Vladimir Lenin, Josef Stalin, Adolf Hitler or Mao Zedong. The actions of dominating leaders are the hardest element to anticipate. At several junctures in the 20th century, Western experts thought liberal and market ideas had triumphed. As demonstrated by the impacts of Churchill, Roosevelt, and Truman, leadership is key even in societies where institutions are strong and the maneuvering room for wielding personal power is more constrained.

- **Economic volatility introduces a major risk factor.** Historians and social scientists have discovered a strong correlation between rapid economic change—both positive and negative—and political instability. The massive dislocation and economic volatility introduced by the end of the "first" globalization in 1914-1918 and the rise of protectionist barriers in the 1920s and 1930s, combined with the lingering resentments over the Versailles peace settlement, laid the groundwork for WW II. The collapse of multinational and ethnic empires—begun after WW I and continuing with the end of the colonial empires in the post-WW II period—also unleashed a long series of national and ethnic conflicts that reverberates today. Today's globalization also has spurred the movement of people, disrupting traditional social and geographic boundaries.

- **Geopolitical rivalries trigger discontinuities more than does technological change.** Many stress the role of technology in bringing about radical change and there is no question it has been a major driver. We—as others—have oftentimes underestimated its impact. However, over the past century, geopolitical rivalries and their consequences have been more significant causes of the multiple wars, collapse of empires, and rise of new powers than technology alone.



Chapter 1

The Globalizing Economy

In terms of size, speed, and directional flow, the global shift in relative wealth and economic power now under way—roughly from West to East—is without precedent in modern history. This shift derives from two key sources. First, sustained increases in oil and commodity prices have generated windfall profits for the Gulf states and Russia. Second, relatively low labor costs combined with certain government policies have shifted the locus of manufacturing and some service industries to Asia. Strong global demand for these products has made for wide economies of scale margins across Asia, particularly in China and India. These shifts in demand and supply are deep and structural, which suggests that the resulting transfer of economic power we are witnessing is likely to endure. These shifts are the driving force behind globalization that—as we underlined in our ***Mapping the Global Future*** report—is a meta-trend, transforming historic patterns of economic flows and underlying stocks, creating pressures for rebalancing that are painful for both rich and poor countries.

"In terms of size, speed, and directional flow, the global shift in relative wealth and economic power now under way—roughly from West to East—is without precedent in modern history."

Although this transfer is not zero-sum, early losers such as most of Latin America (with the exception of Brazil and a few others) and Africa are receiving neither a stake in the initial asset transfer nor any significant inbound investment from the recipient countries. Certain industrialized states such as Japan also appear increasingly challenged by inchoate financial links among these emerging markets. The US and Eurozone are receiving much of this emerging market liquidity, but whether they will benefit relative to their current position depends on several factors, including the ability of Western countries to reduce oil consumption and demand, the ability of these states to capitalize on a favorable export climate in sectors of comparative strength, such as technology and services, and the domestic policies of recipient states, particularly on issues of monetary policy and openness to foreign investment.

Back to the Future

Asia's economic powerhouses—China and India—are restoring the positions they held two centuries ago when China produced approximately 30 percent and India 15 percent of the world's wealth. China and India, for the first time since the 18th century, are set to be the largest contributors to worldwide economic growth. These two countries will likely surpass the GDP of all other economies except the US and Japan by 2025, but they will continue to lag in per capita income for decades. The years around 2025 will be characterized by the "dual identity" of these Asian giants: powerful, but many individual Chinese or Indians feeling relatively poor compared to Westerners.

Growth projections for Brazil, Russia, India, and China have them collectively matching the original G-7's share of global GDP by 2040-2050. According to these same projections, the eight largest economies in 2025 will be, in descending order: the US, China, India, Japan, Germany, the UK, and France, and Russia.

China, especially, has emerged as a new financial heavyweight, claiming $2 trillion in foreign exchange reserves in 2008. Rapidly developing countries, including China and Russia, have created sovereign wealth funds (SWFs)[5] with the aim of using their hundreds

[5] Sovereign wealth funds (SWFs) constitute capital generated from government surpluses and invested in private markets abroad. Since 2005, the number of

of billions of dollars' worth of assets to achieve higher returns to help them weather economic storms. Some of these funds will return to the West in the form of investments, thereby promoting greater productivity and economic competitiveness. However, foreign direct investment (FDI) by emerging powers in the developing world is increasing significantly.

A generation of globally competitive companies is emerging from the new powers, helping to further solidify their position in the global marketplace; from Brazil in agribusiness and offshore energy exploration; Russia in energy and metals; India in IT services, pharmaceuticals, and auto parts; and China in steel, home appliances, and telecommunications equipment. Of the top 100 new global corporate leaders from the non-OECD world listed in a 2006 report from The Boston Consulting Group, 84 were headquartered in Brazil, Russia, China and India.

Growing Middle Class

We are witnessing an unprecedented moment in human history: never before have so many been lifted out of extreme poverty as is happening today. A stunning 135 million people escaped dire poverty between 1999 and 2004 alone—more than the population of Japan and almost as many as live in Russia today.

Over the next several decades the number of people considered to be in the "global middle class" is projected to swell from 440 million to 1.2 billion or from 7.6 percent of the world's population to 16.1 percent, according to the World Bank. Most of the new entrants will come from China and India.

- However, there is a dark side to the global middle class coin: continued divergence at the extremes. Many countries—especially the landlocked and resource-poor ones in Sub Saharan Africa—lack the fundamentals for entering the globalization game. By 2025-2030, the portion of the world considered poor will shrink by about 23 percent, but the world's poor—still 63 percent of the globe's population—stand to become relatively poorer, according to the World Bank.

State Capitalism: A Post-Democratic Marketplace Rising in the East?

The monumental achievement of millions escaping extreme poverty underpins the rise of new powers—especially China and India—on the international scene but does not tell the whole story. Today wealth is moving not just from West to East but is concentrating more under state control. In the wake of the 2008 global financial crisis, the state's role in the economy may be gaining more appeal throughout the world.

With some notable exceptions like India, the states that are beneficiaries of the massive shift of wealth—China, Russia, and Gulf states—are non-democratic and their economic policies blur distinctions between public and private. These states are not following the Western liberal model for self-development but are using a different model—"state capitalism." State capitalism is a loose term to describe a system of

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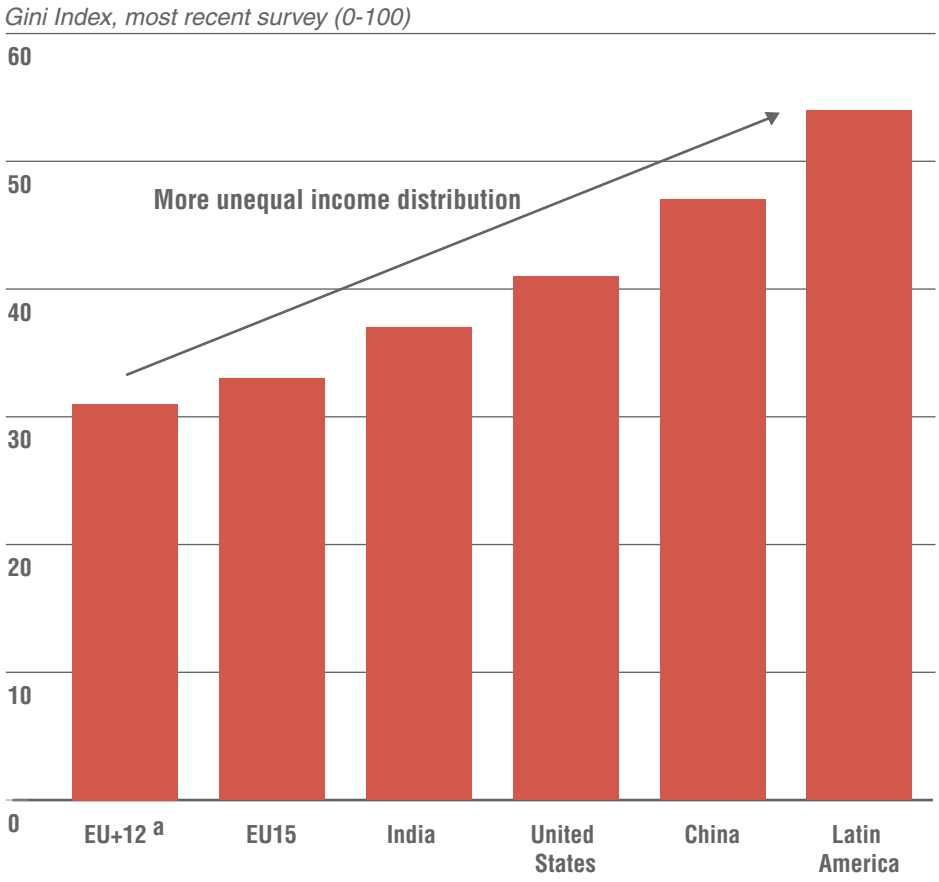
states with SWFs has grown from three to over 40, and the aggregate sum under their control from around $700 billion to $3 trillion. The range of functions served by SWFs also has expanded, as many of the states that created them recently have done so out of a desire to perpetuate current account surpluses, or to cultivate intergenerational savings, rather than to buffer commodity market volatility. Should current trends hold, SWFs will swell to over $6.5 trillion within five years, and to $12-15 trillion within a decade, exceeding total fiscal reserves and comprising some 20 percent of all global capitalization.

Regional Income Inequality: European Inequality Lower Than Most



[a]European Union Nations that acceded in 2004 or later.
Source: UNDP, Human Development Report 2007/2008: World Bank.

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economic management that gives a prominent role to the state.

Others—like South Korea, Taiwan, and Singapore—also chose state capitalism as they initially developed their economies. However, the impact of Russia, and particularly China, following this path is potentially greater given their weight on the world stage. Ironically, the major enhancement of the state role in Western economies now under way as a result of the current financial crisis may reinforce the emerging countries' preference for greater state control and distrust of an unregulated marketplace.

These states typically favor:

- ***An Open Export Climate***. Given the wealth flowing into these states, their desire for a weak currency despite strong domestic economic performance requires heavy intervention in currency markets, leading to heavy official asset accumulation, typically until now in the form of US Treasury bonds.

Globalization at Risk with the 2008 Financial Crisis?

As with most of the trends discussed in this report, the impacts from the financial crisis will depend heavily on government leadership. Proactive fiscal and monetary policies probably will ensure the current panic and likely deep national recessions will not turn into an extended depression, although reduced economic growth could slow globalization's pace, increasing protectionist pressures and financial fragmentation.

The crisis is accelerating the global economic rebalancing. Developing countries have been hurt; several, such as Pakistan with its large current account deficit, are at considerable risk. Even those with cash reserves—such as South Korea and Russia—have been severely buffeted; steep rises in unemployment and inflation could trigger widespread political instability and throw emerging powers off course. However, if China, Russia, and Mideast oil exporters can avoid internal crises, they will be in a position to leverage their likely still sizeable reserves, buying foreign assets and providing direct financial assistance to still-struggling countries for political favors or to seed new regional initiatives. In the West, the biggest change—not anticipated before the crisis—is the increase in state power. Western governments now own large swaths of their financial sectors and must manage them, potentially politicizing markets.

The crisis has increased calls for a new "Bretton Woods" to better regulate the global economy. World leaders, however, will be challenged to renovate the IMF and devise a globally transparent and effective set of rules that apply to differing capitalisms and levels of financial institutional development. Failure to construct a new all-embracing architecture could lead countries to seek security through competitive monetary policies and new investment barriers, increasing the potential for market segmentation.

- ***Sovereign Wealth Funds (SWFs) and Other State Investment Vehicles***. Having amassed huge assets, Gulf Cooperation Council (GCC) and Chinese officials have increasingly used various forms of sovereign investment. States entering private markets are doing so partly for the prospect of higher return. SWFs are the most widely publicized but only one of many sovereign investment vehicles.

- ***Renewed Efforts Toward Industrial Policy.*** Governments that highly manage their economies often have an interest in industrial policy. China, Russia, and the Gulf states have state plans to diversify their economies and climb the value-added ladder into high technology and service sectors. The significant difference between today's efforts and those of earlier periods, however, is that these states now directly own the economic wherewithal to implement their plans and need not rely on incentivizing parties or luring foreign capital.

- ***Rollback of Privatization and the Resurgence of State-Owned Enterprises (SOEs).*** In the early 1990s, many economists predicted that SOEs would be a relic of the 20th century. They were wrong. SOEs are far from extinction, are thriving, and in many cases seek to

expand beyond their own borders, particularly in the commodities and energy sectors. SOEs, especially national oil companies, are likely to attract investment for the surfeit of ready capital that these states are accumulating. Much like SWFs, SOEs serve a secondary function as pressure valves, helping to relieve inflation and currency appreciation pressures. They also can act as vehicles for increased political control. To the extent state-owned firms reach across state borders, they may become vehicles for geopolitical influence, particularly those dealing in key strategic resources such as energy.

The increasing role of the state as a player in emerging markets has contrasted until recently with nearly opposite trends in the West, where the state has struggled to keep pace with private financial engineering, such as derivatives and credit swaps. The seeds of this capital market's depth and complexity date to the 1980s but grew with rising asset prices and bull markets from the 1990s until recently. The financial engineering—based upon a magnitude of leverage unthinkable even a decade ago—in turn has injected an unprecedented degree of risk and volatility into global markets. Greater controls and international regulation—a possible outcome of the current financial crisis—could change this trajectory, although a gap on the role of the state in the economy is likely to remain between the West and the rapidly emerging economic powers.

Bumpy Ride in Correcting Current Global Imbalances

The refusal of emerging markets to allow currency appreciation despite booming economies, together with the willingness of the US to incur greater sums of debt, has created a mutually supporting, albeit ultimately unsustainable cycle of imbalances. Indeed, the Wall Street events of 2008 mark the opening chapters of a larger story of rebalancing and course correction from these imbalances. The righting of these imbalances will be bumpy as the global economy moves into realignment. The difficulties of global economic policy coordination—in part a byproduct of the growing political and financial multipolarity—increase the chances of a bumpy ride.

One of the following developments or a combination could cause an adjustment: a slowdown in US consumption and an attendant increase in the US savings rate, and an increase in demand from emerging Asian markets, particularly China and India. Whether imbalances stabilize or rebound out to 2025 depends in part on the particular lessons that the emerging powers choose to draw from the financial crisis. Some may interpret the crisis as a rationale for hoarding yet more in the way of a cushion, while others—in understanding that few if any emerging economies were immune from the widespread downturn—could come to regard the stockpiling of reserves as less of a priority.

Major financial disruptions and the needed economic and political readjustments have often spread beyond the financial arena. History suggests that this rebalancing will require long-term efforts to establish a new international system. Specific problems to be overcome include:

- ***Greater Trade and Investment Protectionism***. Increasingly aggressive foreign acquisitions by corporations based in the rapidly emerging economies—many will be state-owned—will raise political tensions, potentially creating a public backlash in countries against foreign trade and investment. The perception of uneven benefits from

globalization in the US may fuel protectionist forces.

- ***An Accelerated Resource Grab***. The new powers increasingly will have the means to acquire commodities in an effort to ensure continued development. Russia, China, and India have linked their national security to increased state control of and access to energy resources and markets through their state-owned energy firms. Gulf states are interested in land leases and purchases elsewhere to ensure adequate food supplies.

- ***Slowing Democratization.*** China, particularly, offers an alternative model for political development in addition to demonstrating a different economic pathway. This model may prove attractive to under-performing authoritarian regimes, in addition to weak democracies frustrated by years of economic underperformance.

- ***The Overshadowing of International Financial Institutions***. Sovereign wealth funds have injected more capital into emerging markets than the IMF and World Bank combined, and this trend could even continue with unwinding global imbalances. China already is beginning to couple SWF investment with direct aid and foreign assistance, often directly outbidding the World Bank on development projects. Such foreign investment by newly rich states such as China, Russia, and the GCC states will lead to diplomatic realignments and new relationships between these states and the developing world.

- ***A Decline in the Dollar's International Role***. Despite recent inflows into dollar assets and the appreciation of the dollar, the dollar could lose its status as an unparalleled global reserve currency by 2025, and become a first among equals in a market basket of currencies. This may force the US to consider more carefully how the conduct of its foreign policy affects the dollar. Without a steady source of external demand for dollars, US foreign policy actions might bring exposure to currency shock and higher interest rates for Americans.

Growing use of the euro is already evident, potentially making it harder for the US in the future to exploit the unique role of the dollar in international trade and investment to freeze assets and disrupt the financial flows of its adversaries, such as it recently has accomplished with financial sanctions against the leadership in North Korea and Iran. Incentives and inclinations to move away from the dollar will be tempered, however, by uncertainties and instabilities in the international financial system.

Multiple Financial Nodes

Anchored by the US and EU in the West, Russia and the GCC states in Central Asia and the Middle East, and China and eventually India in the East, the financial landscape for the first time will be genuinely global and multipolar. Insomuch as the recent financial crisis heightens interest in less leveraged finance, Islamic finance may also see a boost. While such a global and multipolar financial order signals a relative decline for US power and a likely increase in market competition and complexity, these downsides are likely to be accompanied by many positives. Over time, and as they develop, these multiple financial centers may create redundancies that help insulate markets against financial shocks and currency crises, quelling their effects before global contagion takes hold. Similarly, as regions become more invested in their financial epicenters, incentives to preserve geopolitical stability to

Science and Technology Leadership: A Test for the Emerging Powers

The relationship between achievements in science and technology and economic growth has been long established, but the path is not always predictable. More significant is the overall effectiveness of a nation's National Innovation System (NIS)—the process by which intellectual concepts are moved toward commercialization for the benefit of a national economy. According to a NIC-contracted global survey of scientific experts, the United States currently boasts a stronger innovation system than the developing economies of China and India.

- The idea of an NIS was first developed in the 1980s as an aid to understanding how some countries were proving better than others at turning intellectual concepts into commercial products that would boost their economies. The NIS model is evolving as information technology and the effect of increased globalization (and multinational corporations) influence national economies.

According to the NIC-commissioned study, nine factors can contribute to a modern NIS: fluidity of capital, flexibility of the labor pool, government receptivity to business, information communication technologies, private sector development infrastructure, legal systems to protect intellectual property rights, available scientific and human capital, marketing skills, and cultural propensity to encourage creativity.

China and India are expected in 10 years to achieve near parity with the US in two different areas: scientific and human capital (India) and government receptivity to business innovation (China). China and India will narrow significantly but not close the gap in all remaining factors. The United States is expected to remain dominant in three areas: protection for intellectual property rights, business sophistication to mature innovation, and encouragement of creativity.

Companies in China, India, and other major developing countries have unique opportunities to be the first to develop a host of emerging technologies. This is especially the case in those instances where companies are building new infrastructure and not burdened by historical patterns of development. Such opportunities include distributed electrical power generation, development of clean water sources, and the next generation of Internet and new information technologies (such as ubiquitous computing and the Internet of Things—see the foldout). Early and significant adoption of these technologies could provide considerable economic advantage.

shelter these financial flows will increase. History suggests, however, that such a redirection toward regional financial centers could soon spill over into other areas of power. Rarely, if ever, have such "financiers of last resort" been content to limit their influence to strictly financial realms. Inter-regional tensions could divide the West with the US and EU having increasingly divergent economic and monetary priorities, complicating Western efforts to lead and jointly grow the global economy.

Diverging Development Models, but for How Long?

The state-centric model in which the state makes the key economic decisions and, in the case of China and increasingly Russia, democracy is restricted, raises questions about the inevitability of the traditional Western recipe—roughly liberal economics and

democracy—for development. Over the next 15-20 years, more developing countries may gravitate toward Beijing's state-centric model rather than the traditional Western model of markets and democratic political systems to increase the chances of rapid development and perceived political stability. While we believe a gap will remain, the enhanced role of the state in Western economies may also lessen the contrast between the two models.

In the Middle East, secularism, which also has been considered an integral part of the Western model, increasingly may be seen as out of place as Islamic parties come into prominence and possibly begin to run governments. As in today's Turkey, we could see both increased Islamization and greater emphasis on economic growth and modernization.

"China, particularly, offers an alternative model for political development in addition to demonstrating a different economic pathway."

The lack of any overarching ideology and the mix-and-match of some of the elements—for example Brazil and India are vibrant market democracies—means the state-centric model does not yet constitute anything like an alternative system and, in our view, is unlikely ever to be one. Whether China liberalizes both politically and economically over the next two decades is a particularly critical test for the long-term sustainability of an alternative to the traditional Western model. Although democratization probably will be slow and may have its own Chinese character, we believe the emerging middle class will press for greater political influence and accountability of those in charge, particularly if the central government falters in its ability to sustain economic growth or is unresponsive to growing "quality of life" issues such as increasing pollution or the need for health and education services. The government's own efforts to boost S&T and establish a "high tech" economy will increase incentives for greater openness to develop human capital at home and attract expertise and ideas from outside.

Historical patterns evinced by other energy producers suggest deflecting pressures for liberalization will be easier for Russian authorities. Traditionally, energy producers also have been able to use revenues to buy off political opponents; few have made the transition to democracy while their energy revenues remain strong.

A sustained plunge in the price of oil and gas would alter the outlook and increase prospects for greater political and economic liberalization in Russia.

Latin America: Moderate Economic Growth, Continued Urban Violence

Many Latin American countries will have achieved marked progress in democratic consolidation by 2025, and some of these countries will have become middle income powers. Others, particularly those that have embraced populist policies, will lag behind—and some, such as Haiti, will have become even poorer and still less governable. Public security problems will continue to be intractable—and in some cases unmanageable. Brazil will become the leading regional power, but its efforts to promote South American integration will be realized only in part. Venezuela and Cuba will have some form of vestigial influence in the region in 2025, but their economic problems will limit their appeal. Unless the United States is able to deliver market access on a permanent and meaningful basis, the US could lose its traditionally privileged position in the region, with a concomitant decline in political influence.

Steady economic growth between now and 2025—perhaps as high as 4 percent—will fuel modest decreases in poverty levels in some countries and a gradual reduction of the informal sector. Progress on critical secondary reforms, such as education, regressive tax systems, weak property rights, and inadequate law enforcement will remain incremental and spotty. The relative growing importance of the region as a producer of oil, natural gas, biofuels, and other alternative energy sources will spur growth in Brazil, Chile, Colombia, and Mexico, but state ownership and political turmoil will impede efficient development of energy resources. The economic competitiveness of Latin America will continue to lag behind Asia and some other fast growing areas.

Population growth in the region will be relatively moderate, but the rural poor and indigenous populations will continue to grow at a faster rate. Latin America will have a graying population as the growth rate of adults aged 60 and over rises.

Parts of Latin America will continue to be among the world's most violent areas. Drug trafficking organizations, sustained in part by increased local drug consumption, transnational criminal cartels, and local crime rings and gangs, will continue to undermine public security. These factors, and persistent weaknesses in the rule of law, will mean that a few small countries, especially in Central America and the Caribbean, will verge on becoming failed states.

Latin America will continue to play a marginal role in the international system, except for its participation in international trade and some peacekeeping efforts.

US influence in the region will diminish somewhat, in part because of Latin America's broadening economic and commercial relations with Asia, Europe, and other blocs. Latins, in general, will look to the United States for guidance both globally and for relations with the region. An increasingly numerous Hispanic population will ensure greater US attention to, and involvement in, the culture, religion, economics, and politics of the region.

Women as Agents of Geopolitical Change

Economic and political empowerment of women could transform the global landscape over the next 20 years. This trend already is evident in the area of economics: ***The explosion in global economic productivity in recent years has been driven as much by fostering human resources—particularly through improvements in health, education, and employment opportunities for women and girls—as by technological advances***.

- The predominance of women in Southeast Asia's export manufacturing sector is a likely key driver of that region's economic success; women agricultural workers account for half the world's food production—even without reliable access to land, credit, equipment, and markets.

- Over the next 20 years the increased entry and retention of women in the workplace may continue to mitigate the economic impacts of global aging.

Women in much of Asia and Latin America are achieving higher levels of education than men, a trend that is particularly significant in a human capital-intensive global economy.

- Demographic data indicate a significant correlation between a higher level of female literacy and more robust GDP growth within a region (e.g., the Americas, Europe, and East Asia). Conversely, those regions with the lowest female literacy rates (southern and western Asia; the Arab world; and Sub-Saharan Africa) are the poorest in the world.

- Improved educational opportunities for girls and women also are a contributing factor to falling birth rates worldwide—and by extension better maternal health. The long-term implications of this trend likely include fewer orphans, less malnutrition, more children in school, and other contributions to societal stability.

Although data on women's ***political*** involvement are less conclusive than those regarding economic participation, political empowerment of women appears to change governmental priorities. ***Examples as disparate as Sweden and Rwanda indicate that countries with relatively large numbers of politically active women place greater importance on societal issues such as healthcare, the environment, and economic development.*** If this trend continues over the next 15-20 years, as is likely, an increasing number of countries could favor social programs over military ones. Better governance also could be a spinoff benefit, as a high number of women in parliament or senior government positions correlates with lower corruption.

Nowhere is the role of women potentially more important for geopolitical change than in the Muslim World. Muslim women do far better assimilating in Europe than their male relatives, partly because they flourish in the educational system, which facilitates their entry into jobs in information or service industries. Sharply declining fertility rates among Muslims in Europe demonstrate this willingness to accept jobs outside the home and a growing refusal to conform to traditional norms. In the short term, the decline of traditional Muslim family structures may help explain the openness of many young Muslim men to radical Islamic messages. However, in

(Continued on next page…)

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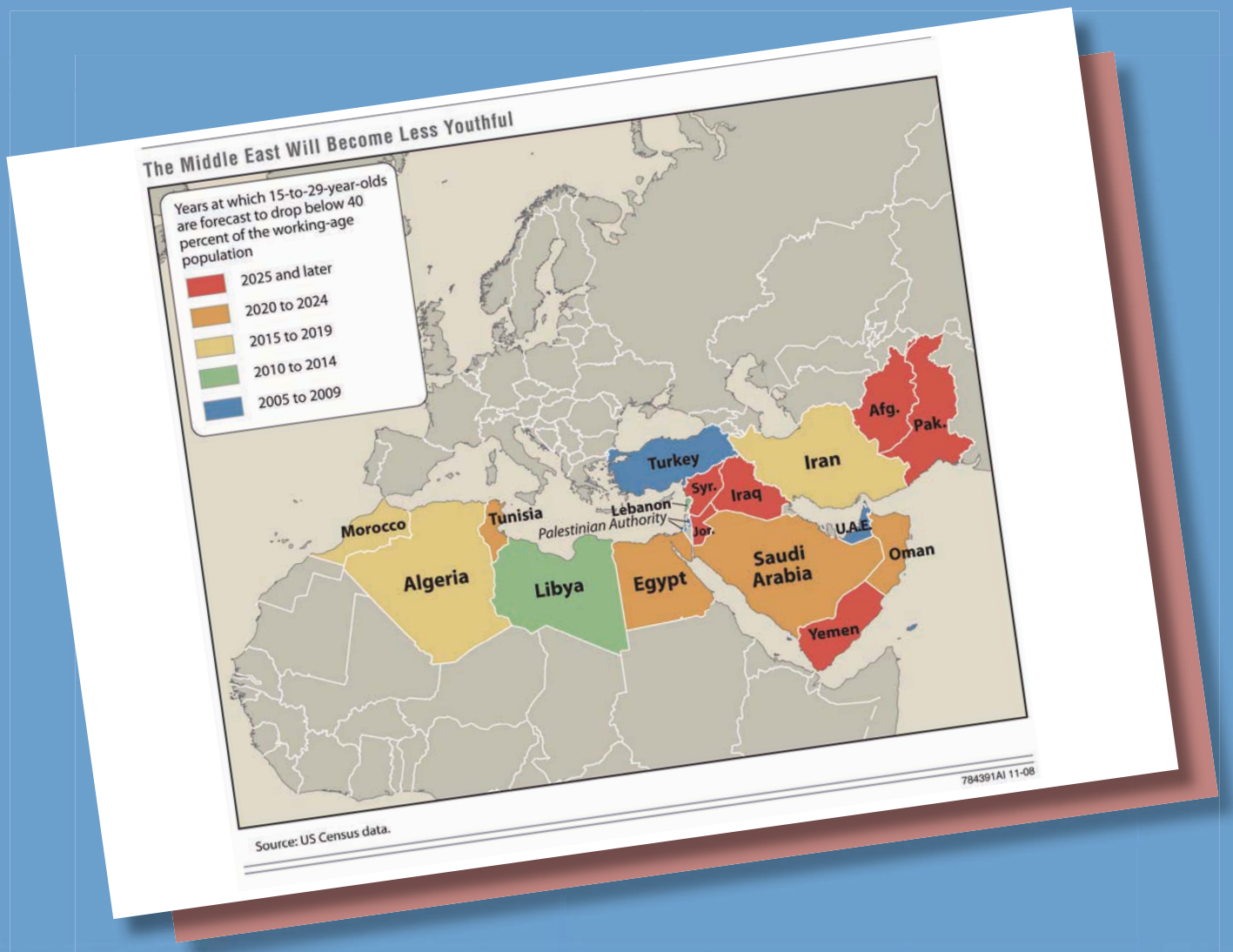
rearing future generations, women might help show the way to greater social assimilation and reduce the likelihood of religious extremism. The impact of growing numbers of women in the workplace may also have an impact outside Europe. The modernizing countries of the Islamic Mediterranean have close ties to Europe, to which these countries have sent many migrants. Migrants return to visit or resettle and bring with them new ideas and expectations. These Islamic countries also receive foreign influences from European mass media, through satellite dishes and the Internet.

Higher Education Shaping the Global Landscape in 2025

As global business grows increasingly borderless and labor markets more seamless, education has become a key determinant of countries' economic performance and potential. Adequate primary education is essential, but the quality and accessibility of secondary and higher education will be even more important for determining whether societies successfully graduate up the value-added production ladder.

The US lead in highly skilled labor will likely narrow as large developing countries, particularly China, begin to reap dividends on recent investments in human capital, including education but also nutrition and healthcare. India faces a challenge because inadequate primary education is widespread in the poorer regions and top-flight educational institutions cater to a relatively privileged few. Funding as a proportion of GDP has grown to around 5 percent in most European countries, although few European universities are rated as world class. Spending on education in the Arab world is roughly on par with the rest of the world in absolute terms and surpasses the global mean as a percentage of GDP, lagging only slightly behind OECD high-income countries. UN data and research findings by other institutions suggest, however that training and education of Middle Eastern youth is not driven by the needs of employers, especially for science and technology. There are some signs of progress.

The US may be uniquely able to adapt its higher education and research system to rising global demand and position itself as a world education hub for the growing number of students that will enter the education market out to 2025. Although further opening of US classrooms and laboratories could mean greater competition for US students, the US economy would likely benefit because companies tend to base their operations near available human capital. Continued export of US educational models with the building of US campuses in the Middle East and Central Asia could boost the attractiveness and global prestige of US universities.



Chapter 2

The Demographics of Discord

Trends in birth, death, and migration are changing the absolute and relative size of young and old, rural and urban, and ethnic majority and minority populations within and among emerging and established powers. These demographic reconfigurations will offer social and economic opportunities for some powers and severely challenge established arrangements in others. The populations of more than 50 countries will increase by more than a third (some by more than two-thirds) by 2025, placing additional stresses on vital natural resources, services, and infrastructure. Two-thirds of these countries are in Sub-Saharan Africa; most of the remaining fast-growing countries are in the Middle East and South Asia.

Populations Growing, Declining, and Diversifying—at the Same Time

World population is projected to grow by about 1.2 billion between 2009 and 2025—from 6.8 billion to around 8 billion people. Although the global population increase is substantial—with concomitant effects on resources—the rate of growth will be slower than it was, down from levels that added 2.4 billion persons between 1980 and today. Demographers project that Asia and Africa will account for most of the population growth out to 2025 while less than 3 percent of the growth will occur in the "West"—Europe, Japan, the United States, Canada, Australia, and New Zealand. In 2025, roughly 16 percent of humanity will live in the West, down from the 18 percent in 2009 and 24 percent in 1980.

- The largest increase will occur in India, representing about one-fifth of all growth. India's population is projected to climb by around 240 million by 2025, reaching approximately 1.45 billion people. From 2009 to 2025, Asia's other giant, China, is projected to add more than 100 million to its current population of over 1.3 billion. (See graphic on page 22.)

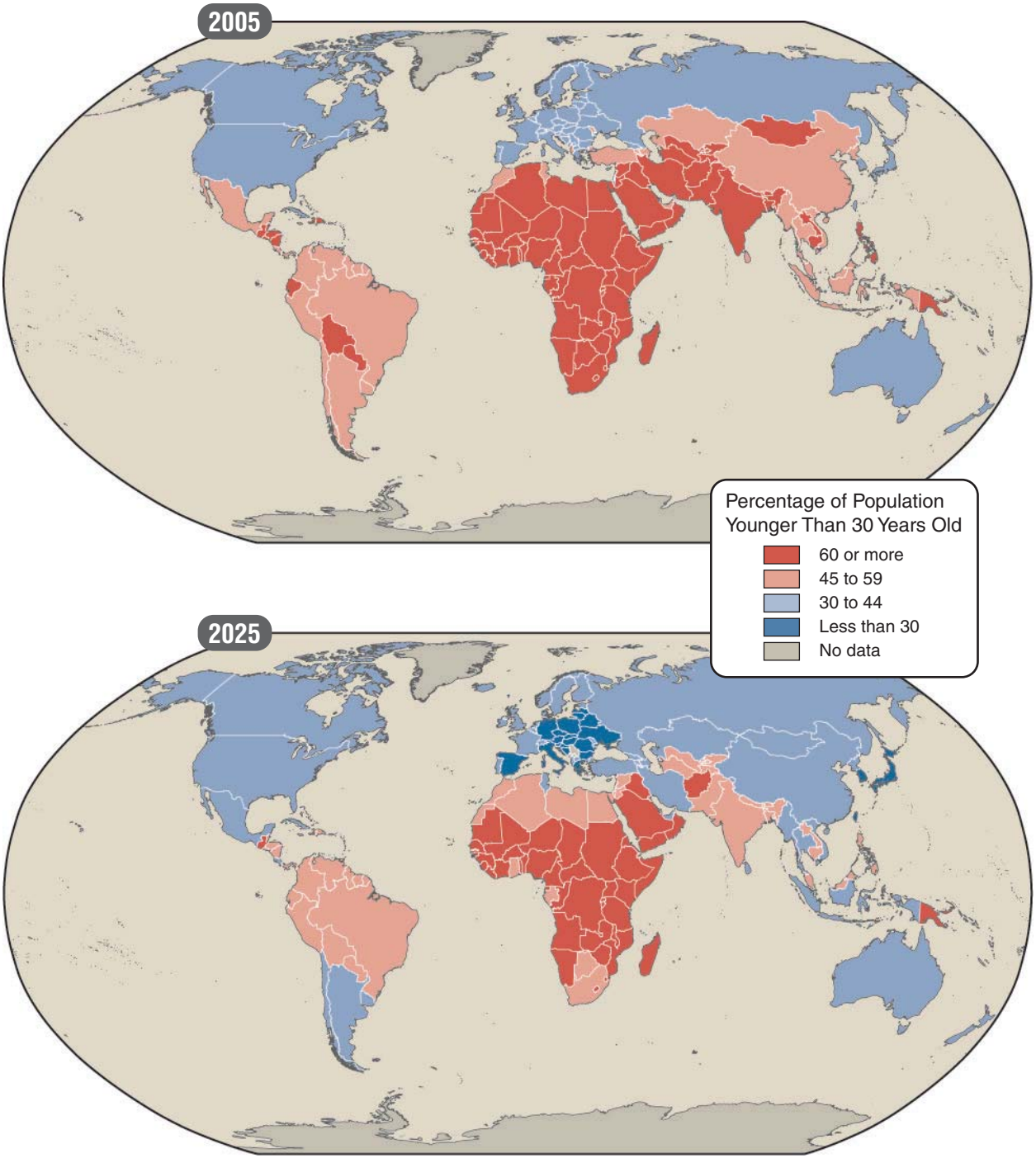
- In aggregate, the countries of Sub-Saharan Africa are projected to add about 350 million people during the same period, while those in Latin America and the Caribbean will increase by about 100 million.

- Between now and 2025, Russia, Ukraine, Italy, almost all countries in Eastern Europe, and Japan are expected to see their populations decline by several percent. These declines could approach or exceed 10 percent of the current populations in Russia, Ukraine, and a few other Eastern European countries.

- The populations of the US, Canada, Australia, and a few other industrial states with relatively high immigration rates will continue to grow—the US by more than 40 million, Canada by 4.5 million, and Australia by more than 3 million.

By 2025, the already diverse array of national population age structures promises to be more varied than ever, and the gap between the youngest and oldest profiles will continue to widen. The "oldest" countries—those in which people under age 30 form less than one-third of the population—will mark a band across the northern edge of the world map. In contrast, the "youngest" countries, where the under-30 group represents 60 percent of the population or more, will nearly all be located in Sub-Saharan Africa. (See maps on page 20.)

World Age Structure, 2005 and Projected 2025



Source: US Census data.

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The Pensioner Boom: Challenges of Aging Populations

Population aging has brought today's developed countries—with a few exceptions such as the US—to a demographic "***tipping point***." Today, nearly 7 out of every 10 people in the developed world are in the traditional working years (ages 15 to 64)—a high-tide mark. This number has never before been so high and, according to experts, in all likelihood will never be so high again.

In almost every developed country, the period of most rapid growth in the ratio of seniors (age 65 and older) to the working-age population will occur during the 2010s and 2020s, boosting the fiscal burden of old-age benefit programs. By 2010, there will be about one senior for every four working-age people in the developed world. By 2025, this ratio will have climbed to one to three, and possibly higher.

- Japan is in a difficult position: its working-age population has been contracting since the mid-1990s and its overall population since 2005. Today's projections envision a society in which, by 2025, there will be one senior for every two working-age Japanese.

- The picture for Western Europe is more mixed. The UK, France, Belgium, the Netherlands, and the Nordics will likely maintain the highest fertility rates in Europe but will remain below two children per woman. In the rest of the region, fertility probably will stay below 1.5 children per woman, on par with Japan (and well below the replacement level of 2.1 children per woman).

Large and sustained increases in the fertility rate, even if they began now, would not reverse the aging trend for decades in Europe and Japan. If fertility rose immediately to the replacement level in Western Europe, the ratio of seniors to people in their working years would continue to rise steadily through the late 2030s. In Japan, it would continue to rise through the late 2040s.

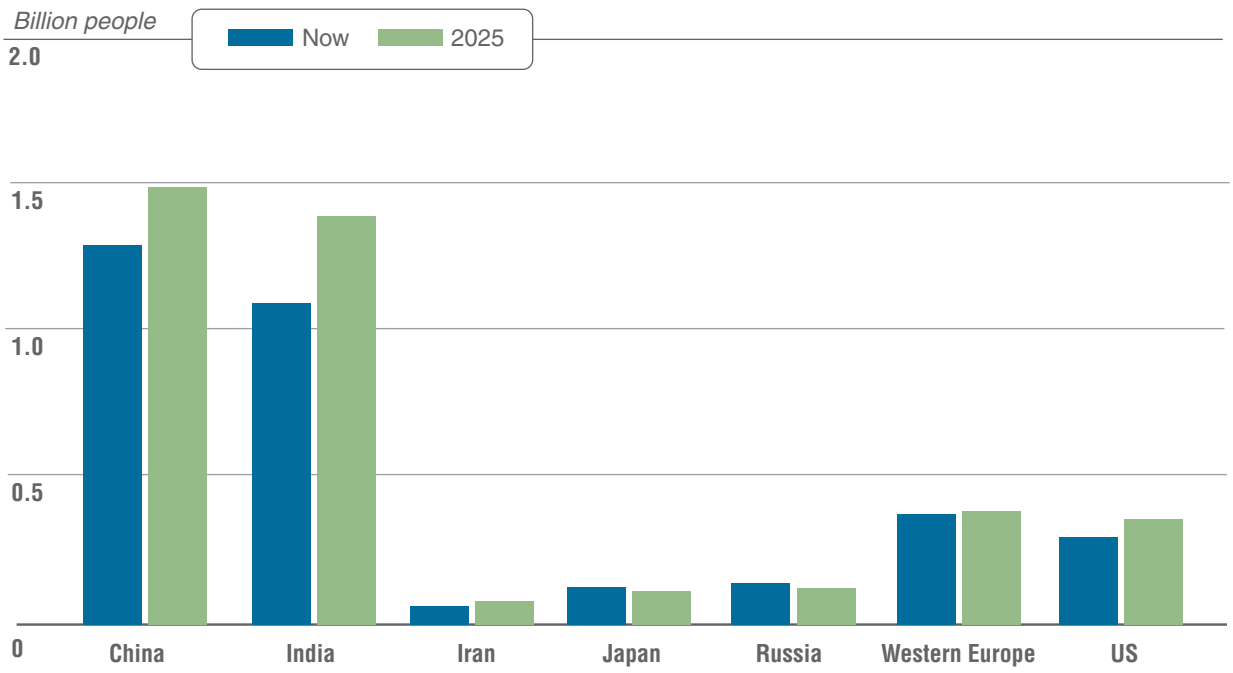
The annual level of net immigration would have to double or triple to keep working-age populations from shrinking in Western Europe. By 2025, non-European minority populations could reach significant proportions—15 percent or more—in nearly all Western European countries and will have a substantially younger age structure than the native population (see page 20). Given growing discontent with current levels of immigrants among native Europeans, such steep increases are likely to heighten tensions.

The aging of societies will have economic consequences. Even with productivity increases, slower employment growth from a shrinking work force probably will reduce Europe's already tepid GDP growth by 1 percent. By the 2030s, Japan's GDP growth is projected to drop to near zero according to some models. The cost of trying to maintain pensions and health coverage will squeeze out expenditures on other priorities, such as defense.

Persistent Youth Bulges

Countries with youthful age structures and rapidly growing populations form a crescent stretching from the Andean region of Latin America across Sub-Saharan Africa, the Middle East and the Caucasus, and then through the northern parts of South Asia. By 2025, the number of countries in this "arc of instability" will have decreased by 35 to 40 percent owing to declining fertility and maturing populations. Three quarters of the three dozen "youth bulge countries" projected to linger beyond 2025 will be located in Sub-Saharan Africa. The remainder will be

Total Population



Source: US Census Data

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located in the Middle East and scattered across Asia and among the Pacific Islands.

- The emergence of new economic tigers by 2025 could occur where youth bulges mature into "worker bulges." Experts argue that this demographic bonus is most advantageous when the country provides an educated work force and a business-friendly environment for investment. Potential beneficiaries include Turkey, Lebanon, Iran, and the Maghreb states of North Africa (Morocco, Algeria and Tunisia), Colombia, Costa Rica, Chile, Vietnam, Indonesia, and Malaysia.

- The current youth bulges in the Maghreb states, Turkey, Lebanon, and Iran will diminish rapidly but those in the West Bank/Gaza, Iraq, Yemen, Saudi Arabia and adjacent Afghanistan and Pakistan will persist through 2025. Unless employment conditions change dramatically, youth in weak states will continue to go elsewhere—externalizing volatility and violence.

The populations of already parlous youth-bulge states—such as Afghanistan, Democratic Republic of Congo (DROC), Ethiopia, Nigeria, Pakistan, and Yemen—are projected to remain on rapid-growth trajectories. Pakistan's and Nigeria's populations are each projected to grow by about 55 million people. Ethiopia and DROC will likely add about 40 million each, while the populations of Afghanistan and Yemen are projected to grow more than 50 percent larger than today's. All will retain age structures with large proportions of young

The Impact of HIV/AIDS

Neither an effective HIV vaccine nor a self-administered microbicide, even if developed and tested before 2025, will likely be widely disseminated by then. Although prevention efforts and local behavioral changes will depress infection rates globally, experts expect HIV/AIDS to remain a global pandemic through 2025 with its epicenter of infection in Sub-Saharan Africa. Unlike today, the vast majority of people living with HIV will have access to life-extending anti-retroviral therapies.

- If prevention efforts and effectiveness remain at current levels, the HIV-positive population is expected to climb to around 50 million by 2025—up from 33 million today (22 million in Sub-Saharan Africa). In this scenario, 25 million to 30 million people would need anti-retroviral therapy to survive during 2025.

- In another scenario assuming fully scaled-up prevention by 2015, the HIV-infected population would peak and then fall to near 25 million worldwide by 2025, bringing the number needing anti-retroviral therapy to between 15 and 20 million people.

adults, a demographic feature that is associated with the emergence of political violence and civil conflict.

Changing Places: Migration, Urbanization and Ethnic Shifts

Moving Experiences. The net migration of people from rural to urban areas and from poorer to richer countries likely will continue apace in 2025, fueled by a widening gap in economic and physical security between adjacent regions.

- Europe will continue to attract migrants from younger, less developed, and faster growing African and Asian regions nearby. However, other emerging centers of industrialization—China and southern India and possibly Turkey and Iran—could attract some of this labor migration as growth among their working-age populations slows and wages rise.

- Labor migration to the United States probably will slow as Mexico's industrial base grows and its population ages—a response to rapid fertility declines in the 1980s and 1990s—and as competing centers of development arise in Brazil and the southern cone of South America.

Urbanization. If current trends persist, by 2025 about 57 percent of the world's population will live in urban areas, up from about 50 percent today. By 2025, the world will add another eight megacities to the current list of 19—all except one of these eight will be in Asia and Sub-Saharan Africa. Most urban growth, however, will occur in smaller cities of these regions, which are expanding along highways and coalescing near crossroads and coastlines, often without formal sector job growth and without adequate services.

Identity Demography. Where ethno-religious groups have experienced their transition to lower birth rates at varying paces, lingering ethnic youth bulges and shifts in group proportions could trigger significant political changes. Shifts in ethno-religious composition resulting from migration also could fuel political change, particularly where immigrants settle in low-fertility industrialized countries.

- Differing rates of growth among Israel's ethnic communities could abet political shifts in the Knesset (Israel's parliament).

By 2025, Israeli Arabs, who currently comprise a fifth of the population, will comprise about a quarter of Israel's expected population of nearly 9 million. Over the same period, Israel's ultra-orthodox Jewish community could nearly double, becoming larger than 10 percent of the population.

- Irrespective of their political status in 2025, the populations of the West Bank, currently about 2.6 million people, and Gaza, now at 1.5 million, will have grown substantially: the West Bank by nearly 40 percent; Gaza by almost 60 percent. Their combined population in 2025—still youthful, growing, and approaching 6 million (or exceeding that figure, according to some projections)—promises to introduce further challenges to institutions hoping to generate adequate employment and public services, maintain sufficient availability of fresh water and food, and achieve political stability.

A number of other ethnic shifts between now and 2025 will have regional implications. For example, growing proportions of Native Americans in several Andean and Central American democracies are likely to continue to push governments in those countries toward populism. In Lebanon, ongoing fertility decline in the Shiite population, which currently lags ethnic neighbors in income and exceeds them in family size, will bring about a more mature age structure in this community—and could deepen Shiite integration into the mainstream of Lebanese economic and political life, easing communal tensions.

Western Europe has become the destination of choice for more than one million immigrants annually and home for more than 35 million foreign born—many from Muslim-majority countries in North Africa, the Middle East, and South Asia (see box on page 25). Immigration and integration politics, and confrontations with Muslim conservatives over education, women's rights, and the relationship between the state and religion are likely to strengthen right-of-center political organizations and splinter the left-of-center political coalitions that were instrumental in building and maintaining Europe's welfare states.

By 2025, international migration's human capital and technological transfer effects will begin to favor the most stable Asian and Latin American countries. Although the emigration of professionals probably will continue to deprive poor and unstable countries across Africa and parts of the Middle East of talent, the likely return of many wealthy and educated Asian and Latin Americans from the US and Europe will help boost the competitiveness of China, Brazil, India, and Mexico.

Demographic Portraits: Russia, China, India, and Iran

Russia: A Growing Multiethnic State?

Currently a country with around 141 million people, Russia's demographically aging and declining population is projected to drop below 130 million by 2025. The chances of stemming such a steep decline over this period are slim: the population of women in their 20s—their prime childbearing years—will be declining rapidly, numbering around 55 percent of today's count by 2025.

Russia's high rate of male middle-age mortality is unlikely to change dramatically. Muslim minorities that have maintained higher fertility will comprise larger proportions of the Russian population, as will Turkic and Chinese immigrants. According to some more conservative projections, the Muslim minority share of Russia's population will rise from 14 percent in 2005 to 19

Muslims in Western Europe

Western Europe's Muslim population currently totals between 15 and 18 million. The largest proportions of Muslims—between 6 and 8 percent—are in France (5 million) and the Netherlands (nearly 1 million), followed by countries with 4 to 6 percent: Germany (3.5 million), Denmark (300,000), Austria (500,000), and Switzerland (350,000). The UK and Italy also have relatively large Muslim populations, 1.8 million and 1 million respectively, though constituting less overall proportions (3 percent and 1.7 percent respectively). If current patterns of immigration and Muslim residents' above-average fertility continue, Western Europe could have 25 to 30 million Muslims by 2025.

Countries with growing numbers of Muslims will experience a rapid shift in ethnic composition, particularly around urban areas, potentially complicating efforts to facilitate assimilation and integration. Economic opportunities are likely to be greater in urban areas, but, in the absence of growth in suitable jobs, the increasing concentration could lead to more tense and unstable situations, such as occurred with the 2005 Paris surburban riots.

Slow overall growth rates, highly regulated labor markets, and workplace policies, if maintained, will make it difficult to increase job opportunities, despite Europe's need to stem the decline of its working-age population. When coupled with job discrimination and educational disadvantage, these factors are likely to confine many Muslims to low-status, low-wage jobs, deepening ethnic cleavages. Despite a sizeable stratum of integrated Muslims, a growing number—driven by a sense of alienation, grievance, and injustice—are increasingly likely to value separation in areas with Muslim-specific cultural and religious practices.

Although immigrant communities are unlikely to gain sufficient parliamentary representation to dictate either domestic or foreign policy agendas by 2025, Muslim-related issues will be a growing focus and shaper of the European political scene. Ongoing societal and political tension over integration of Muslims is likely to make European policymakers increasingly sensitive to the potential domestic repercussions of any foreign policies for the Middle East, including aligning too closely with the US on policies seen as pro-Israeli.

percent in 2030, and 23 percent in 2050. In a shrinking population, the growing proportion that are not Orthodox Slavs will likely provoke a nationalist backlash. Because Russia's fertility and mortality problems are likely to persist through 2025, Russia's economy—unlike Europe's and Japan's—will have to support the large proportion of dependents.

Antique China? By 2025, demographers expect China to have almost 1.4 billion people, nearly 100 million above its current population. The advantageous condition of having a relatively large working population and small proportions of both old-age and childhood dependents will begin to fade around 2015, when the size of China's working-age population will start to decline. Demographic aging—the onset of larger proportions of retirees and relatively fewer workers—is being accelerated by decades of policies that have limited childbirth and by a tradition of early retirement. By opting to slow population growth dramatically in order to dampen growing demand for energy, water,

and food, China is hastening the aging of its population. By 2025, a large proportion of China's population will be retired or entering retirement. Although China may over time reverse its restrictive policies on childbearing to achieve birth cohorts more closely balancing infant girls and boys, marriage-age adults in 2025 will still experience a significant male-dominated imbalance that will create a large pool of unmarried males.

Two Indias. India's current fertility rate of 2.8 children per woman masks vast differences between the low-fertility states of South India and the commercial hubs of Mumbai, Delhi, and Kolkata on the one hand, and the higher rates of populous states in the so-called Hindi-speaking belt across the north, where women's status is low and services lag. Largely owing to growth in India's densely populated northern states, its population is projected to overtake China's around 2025—just as China's population is projected to peak and begin a slow decline.

By then, India's demographic duality will have widened the gap between north and south. By 2025, much of India's work force growth will come from the most poorly educated, impoverished, and crowded districts of rural northern India. Although North Indian entrepreneurial families have lived for decades in southern cities, the arrival of whole communities of Hindi-speaking unskilled laborers looking for work could rekindle dormant animosities between India's central government and ethno-nationalist parties in the South.

Iran's Unique Trajectory. Having experienced one of the most rapid fertility declines in history—from more than six children per woman in 1985 to less than two today—Iran's population is destined for dramatic changes by 2025. The country's politically restless, job-hungry youth bulge will largely dissipate over the next decade, yielding more mature population and work force growth rates comparable to current rates in the US and China (near 1 percent per year). In this time frame, the working-age population will grow large relative to children, creating opportunities to accumulate savings, better educate, and eventually to shift to more technical industries and raise living standards. Whether Iran capitalizes on this demographic bonus depends on the country's political leadership, which at present is unfriendly to markets and private businesses, unsettling for investors, and more focused on oil revenues than on broader job creation.

Two additional demographic near-certainties are apparent: first, despite low fertility, Iran's population of 66 million will grow to around 77 million by 2025. Second, by then, a new youth bulge (an echo produced by births during the current one) will be ascending—but in this one, 15-to-24 year olds will account for just one-sixth of those in the working age group compared to one third today. Some experts believe this echo bulge signals a resurgence of revolutionary politics. Others speculate that, in the more educated and developed Iran of 2025, young adults will find career and consumption more attractive than extremist politics. Only one aspect of Iran's future is sure: its society will be more demographically mature than ever before and strikingly different than its neighbors.

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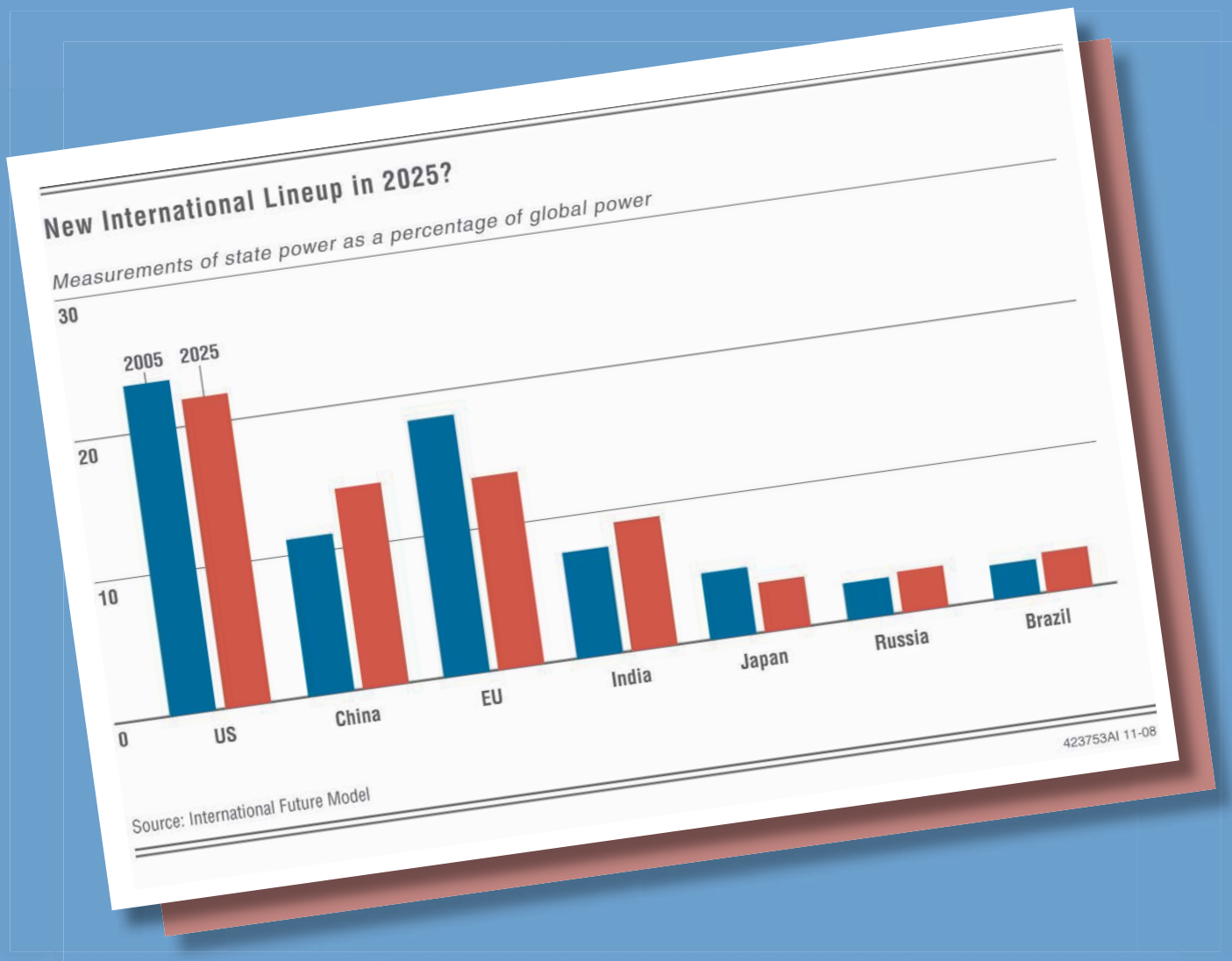


Chapter 3
The New Players

By 2025, the United States will find itself in the position of being one of a number of important actors on the world stage, albeit still the most powerful one. The relative political and economic clout of many countries will shift by 2025, according to an International Futures model measuring GDP, defense spending, population, and technology for individual states (see graphic on page 28).[6] Historically, *emerging* multipolar systems have been more unstable than bipolar or even unipolar ones; the greater diversity and growing power of more countries portends less cohesiveness and effectiveness for the international system. Most emerging powers already want a greater say and, along with many Europeans, dispute the notion of any one power having the right to be a hegemon. The potential for less cohesiveness and more instability also is suggested by the relatively steeper declines in national power of Europe and Japan.

Although we believe chances are good that China and India will continue to rise, their ascent is not guaranteed and will require overcoming high economic and social hurdles. Because of this, both countries are likely to remain inwardly focused and per capita wealth will lag substantially behind Western economies throughout the period to 2025 and beyond. Individuals in these emerging economic powerhouses are likely to feel still poor in relation to Westerners even though their collective GDP increasingly will outdistance those of individual Western states. For Russia, remaining in the top tier where it has been since its remarkable resurgence during the late 1990s and early part of the 21st century may be extremely difficult. Demography is not always destiny, but diversifying the economy so that Russia can maintain its standing after the world transitions away from dependence on fossil fuel will be central to its long-term prospects. Europe and Japan also will be confronting demographic challenges; decisions taken now are likely to determine their long-term trajectories.

Although the rise of no other state can equal the impact of the rise of such populous states as China and India, other countries with potentially high-performing economies—Iran, Indonesia, and Turkey, for example—could play increasingly important roles on the world stage and especially for establishing new patterns in the Muslim world.

"Few countries are poised to have more impact on the world over the next 15-20 years than China."

Rising Heavyweights: China and India

China: Facing Potential Bumps in the Road. Few countries are poised to have more impact on the world over the next 15-20 years than China. If current trends persist, by 2025 China will have the world's second largest economy and will be a leading military power. It could also be the largest importer of natural resources and an even greater polluter than it is now.

- US security and economic interests could face new challenges if China becomes a peer competitor that is militarily strong as well as economically dynamic and energy hungry.

The pace of China's economic growth almost certainly will slow, or even recede, even with additional reforms to address mounting social pressures arising from growing income disparities, a fraying social safety net, poor business regulation, hunger for foreign

[6] National Power scores are the product of an index combining the weighted factors of GDP, defense spending, population, and technology. Scores are calculated by the International Futures computer model and are expressed as a state's relative share (percentage) of all global power.

energy, enduring corruption, and environmental devastation. Any of these problems might be soluble in isolation, but the country could be hit by a "perfect storm" if many of them demand attention at the same time. Even if the Chinese Government can manage to address these issues, it will not have the ability to assure high levels of economic performance. Most of China's economic growth will continue to be domestically driven, but key sectors rely on foreign markets, resources, and technology as well as globalized production networks. As a result, China's economic health will be affected by that of other economies—particularly the United States and the EU.

In addressing these challenges, Chinese leaders must balance the openness necessary to sustain economic growth—essential to public tolerance for the Communist Party's monopoly of political power—against the restrictions necessary to protect that monopoly. Facing so many social and economic changes, the Communist Party and its position are likely to undergo further transformations. Indeed, Communist Party leaders themselves talk openly about the need to find new ways to retain public acceptance of the Party's dominant role. So far, however, these efforts do not appear to include opening the system to free elections and a free press. Moreover, barring the "perfect storm" described above, we do not foresee social pressures forcing real democracy in China by 2025. That said, the country could be moving toward greater political pluralism and more accountable governance.

Chinese leaders could, however, continue managing tensions by achieving significant growth without jeopardizing the Party's political monopoly, as they have for the past three decades. Although a protracted slump could pose a serious political threat, the regime would be tempted to deflect public criticism by blaming China's woes on foreign interference, stoking the more virulent and xenophobic forms of Chinese nationalism.

- Historically, people who become accustomed to rising living standards react angrily when their expectations are no longer met, and few people have had grounds for such high expectations as do the Chinese.

- China's international standing is based partly on foreigners' calculations that it is "the country of the future." If foreigners treat the country less deferentially, nationalistic Chinese could respond angrily.

India: A Complicated Rise. Over the next 15-20 years, Indian leaders will strive for a multipolar international system, with New Delhi as one of the poles and serving as a political and cultural bridge between a rising China and the United States. India's growing international confidence, derived primarily from its economic growth and its successful democratic record, now drives New Delhi toward partnerships with many countries. However, these partnerships are aimed at maximizing India's autonomy, not at aligning India with any country or international coalition.

India probably will continue to enjoy relatively rapid economic growth. Although India faces lingering deficiencies in its domestic infrastructure, skilled labor, and energy production, we expect the nation's rapidly expanding middle class, youthful population, reduced reliance on agriculture, and high domestic savings and investment rates to propel continued economic growth. India's impressive economic growth over the past 15 years has reduced the number of people living in absolute poverty, but the

growing gap between rich and poor will become a more important political issue.

We believe Indians will remain strongly committed to democracy, but the polity could become more fragmented and fractious, with national power being shared across successive political coalitions. Future elections are likely to be multi-sided affairs yielding awkward coalitions with unclear mandates. The general direction of India's economic policymaking is unlikely to be reversed, but the pace and scale of reform will fluctuate.

Regional and ethnic insurgencies that have plagued India since independence are likely to persist, but they will not threaten India's unity. We assess New Delhi will remain confident that it can contain the Kashmiri separatist movement. However, India is likely to experience heightened violence and instability in several parts of the country because of the growing reach of the Maoist Naxalite movement.

Indian leaders do not see Washington as a military or economic patron and now believe the international situation has made such a benefactor unnecessary. New Delhi will, however, pursue the benefits of favorable US ties, partly, too, as a hedge against any development of hostile ties with China. Indian policymakers are convinced that US capital, technology, and goodwill are essential to India's continued rise as a global power. The United States will remain one of India's largest export destinations, the key to international financial institutions such as the World Bank and foreign commercial lending, and the largest source of remittances. The Indian diaspora—composed largely of highly skilled professionals—will remain a key element in deepening US-Indian ties. The Indian market for US goods will grow substantially as New Delhi reduces restrictions on trade and investment. India's military also will be eager to benefit from expanded defense ties with Washington. Indian leaders, however, probably will avoid ties that could resemble an alliance relationship.

"Russia has the potential to be richer, more powerful, and more self-assured in 2025….[but] multiple constraints could limit Russia's ability to achieve its full economic potential."

Other Key Players

Russia's Path: Boom or Bust. Russia has the potential to be richer, more powerful, and more self-assured in 2025 if it invests in human capital, expands and diversifies its economy, and integrates with global markets. On the other hand, multiple constraints could limit Russia's ability to achieve its full economic potential. Chief among them are a shortfall in energy investment, key infrastructure bottlenecks, decaying education and public health sectors, an underdeveloped banking sector, and crime and corruption. A sooner-than-expected conversion to alternative fuels or a sustained plunge in global energy prices before Russia has the chance to develop a more diversified economy probably would constrain economic growth.

Russia's population decline by 2025 will force hard policy choices. By 2017, for example, Russia is likely to have only 650,000 18-year-old males from which to maintain an army that today relies on 750,000 conscripts. Population decline also could take an economic toll with severe labor force shortages, particularly if Russia does not invest more in its existing human capital, rebuild its S&T base, and employ foreign labor migrants.

If Russia diversifies its economy, it could develop a more pluralistic, albeit not

democratic, political system—the result of institutional consolidation, a rising middle class, and the emergence of new stakeholders demanding a greater voice.

A more proactive and influential foreign policy seems likely, reflecting Moscow's reemergence as a major player on the world stage; an important partner for Western, Asian, and Middle East capitals; and a leading force in opposition to US global dominance. Controlling key energy nodes and links in the Caucasus and Central Asia—vital to its ambitions as an energy superpower—will be a driving force in reestablishing a sphere of influence in its Near Abroad. Shared perceptions regarding threats from terrorism and Islamic radicalism could align Russian and Western security policies more tightly, notwithstanding disagreements on other issues and a persisting "values gap."

The range of possible futures for Russia remains wide because of starkly divergent forces—liberal economic trends and illiberal political trends. The tension between the two trends—together with Russia's sensitivity to potential discontinuities sparked by political instability, a major foreign policy crisis, or other wild cards—makes it impossible to exclude alternative futures such as a nationalistic, authoritarian petro-state or even a full dictatorship, which is an unlikely but nevertheless plausible future. Less likely, Russia could become a significantly more open and progressive country by 2025.

Europe: Losing Clout in 2025. We believe Europe by 2025 will have made slow progress toward achieving the vision of current leaders and elites: a cohesive, integrated, and influential global actor able to employ independently a full spectrum of political, economic, and military tools in support of European and Western interests and universal ideals. The European Union would need to resolve a perceived democracy gap dividing Brussels from European voters and move past the protracted debate about its institutional structures.

The EU will be in a position to bolster political stability and democratization on Europe's periphery by taking in additional new members in the Balkans, and perhaps Ukraine and Turkey. However, continued failure to convince skeptical publics of the benefits of deeper economic, political, and social integration and to grasp the nettle of a shrinking and aging population by enacting painful reforms could leave the EU a hobbled giant distracted by internal bickering and competing national agendas, and less able to translate its economic clout into global influence.

The drop-off in working-age populations will prove a severe test for Europe's social welfare model, a foundation stone of Western Europe's political cohesion since World War II. Progress on economic liberalization is likely to continue only in gradual steps until aging populations or prolonged economic stagnation force more dramatic changes—a crisis point that may not hit before some time in the next decade and might be pushed off even further. There are no easy fixes for Europe's demographic deficits except likely cutbacks in health and retirement benefits, which most states have not begun to implement or even to contemplate. Defense expenditures are likely to be cut further to stave off the need for serious restructuring of social benefits programs. The challenge of integrating immigrant, especially Muslim, communities will become acute if citizens faced with a sudden lowering of expectations resort to more narrow nationalism and concentrate on parochial interests, as happened in the past.

Europe's strategic perspective is likely to remain narrower than Washington's, even if the EU succeeds in making reforms that create a "European President" and "European Foreign Minister" and develops greater institutional capacity for crisis management. Divergent threat perceptions within Europe and the likelihood that defense spending will remain uncoordinated suggest the EU will not be a major military power by 2025. The national interests of the bigger powers will continue to complicate EU foreign and security policy and European support for NATO could erode.

The question of Turkey's EU membership will be a test of Europe's outward focus between now and 2025. Increasing doubts about Turkey's chances are likely to slow its implementation of political and human rights reforms. Any outright rejection risks wider repercussions, reinforcing arguments in the Muslim world—including among Europe's Muslim minorities—about the incompatibility of the West and Islam. Crime could be the gravest threat inside Europe as Eurasian transnational organizations—flush from involvement in energy and mineral concerns—become more powerful and broaden their scope. One or more governments in Eastern or Central Europe could fall prey to their domination.

Europe will remain heavily dependent on Russia for energy in 2025, despite efforts to promote energy efficiency and renewable energy and lower greenhouse gas emissions. Varying levels of dependence, differing perspectives on Russia's democratic maturity and economic intentions, and failure to achieve consensus on Brussels' role are hampering nascent efforts to develop common EU polices on energy diversification and security. In the absence of a collective approach that would reduce Russia's leverage, this dependence will foster constant attentiveness to Moscow's interests by key countries, including Germany and Italy, who see Russia as a reliable supplier. Europe could pay a price for its heavy dependence, especially if Russian firms are unable to fulfill contract commitments because of underinvestment in their natural gas fields or if growing corruption and organized criminal involvement in the Eurasian energy sector spill over to infect Western business interests.

Japan: Caught Between the US and China. Japan will face a major reorientation of its domestic and foreign policies by 2025 yet maintain its status as an upper middle rank power. Domestically, Japan's political, social, and economic systems will likely be restructured to address its demographic decline, an aging industrial base, and a more volatile political situation. Japan's decreasing population may force authorities to consider new immigration policies like a long-term visa option for visiting workers. The Japanese, however, will have difficulty overcoming their reluctance to naturalize foreigners. The aging of the population also will spur development in Japan's healthcare and housing systems to accommodate large numbers of dependent elderly.

The shrinking work force—and Japan's cultural aversion to substantial immigrant labor—will put a major strain on Japan's social services and tax revenues, leading to tax increases and calls for more competition in the domestic sector to lower the price of consumer goods. We anticipate continued restructuring of Japan's export industries, with increased emphasis on high technology products, value-added production, and information technologies. The shrinking of Japan's agricultural sector will continue, perhaps down to just 2 percent of the labor force, with a corresponding increase in payments for food imports. The working-age population, declining in absolute numbers,

includes a large number of unemployed and untrained citizens in their late teens and 20s. This could lead to a shortage of white collar workers.

With increasing electoral competition, Japan's one-party political system probably will fully disintegrate by 2025. The Liberal Democratic Party may split into a number of contending parties, but it is more likely that Japan will witness a continual splitting and merging of competing political parties, leading to policy paralysis.

On the foreign front, Japan's policies will be influenced most by the policies of China and the United States, where four scenarios are possible.

- In the first scenario, a China that continues its current economic growth pattern will be increasingly important to Japan's economic growth, and Tokyo will work to maintain good political relations and increase market access for Japanese goods. Tokyo may seek a free trade agreement with Beijing well before 2025. At the same time, China's military power and influence in the region will be of increasing concern to Japanese policymakers. Their likely response will be to draw closer to the United States, increase their missile defense and anti-submarine warfare capabilities, seek to develop regional allies such as South Korea, and push for greater development of international multilateral organizations in East Asia, including an East Asian Summit.

- In a second scenario, China's economic growth falters or its policies become openly hostile toward countries in the region. In response, Tokyo would likely move to assert its influence, in part by seeking to rally democratic states in East Asia, and in part by continuing to develop its own national power through advanced military hardware. Tokyo would assume strong support from Washington in this circumstance and would move to shape political and economic forums in the region to isolate or limit Chinese influence. This would cause states in the region to make a difficult choice between their continued unease with Japanese military strength and a China that has the potential to dominate nearly all nations near its borders. As a result, Japan might find itself dealing with an ad-hoc non-aligned movement of East Asian states seeking to avoid being entrapped by either Tokyo or Beijing.

- In a third scenario, should the United States' security commitment to Japan weaken or be perceived by Tokyo as weakening, Japan may decide to move closer to Beijing on regional issues and ultimately consider security arrangements that give China a de facto role in maintaining stability in ocean areas near Japan. Tokyo is highly unlikely to respond to a loss of the US security umbrella by developing a nuclear weapons program, short of clearly aggressive intent by China toward Japan.

- A fourth scenario would see the United States and China move significantly toward political and security cooperation in the region, leading to US accommodation of a Chinese military presence in the region and a corresponding realignment or drawdown of US forces there. In this case, Tokyo almost certainly would follow the prevailing trend and move closer to Beijing to be included in regional security and political arrangements. Similarly, others in the region, including South Korea, Taiwan, and ASEAN members likely would follow such a US lead, putting further pressure on Tokyo to align

its policies with those of the other actors in the region.

Brazil: Solid Foundation for an Enhanced Leadership Role. By 2025 Brazil probably will be exercising greater regional leadership, as first among equals in South American fora, but aside from its growing role as an energy producer and its role in trade talks, it will demonstrate limited ability to project beyond the continent as a major player in world affairs. Its progress in consolidating democracy and diversifying its economy will serve as a positive regional model.

The country's maturing commitment to democracy is on a secure footing with fair and open electoral processes and smooth transitions having become routine. The current President, Lula da Silva, has a strong socialist orientation and has pursued a moderate policy course domestically and internationally, setting a positive precedent for his successors. Brazilian views about the importance of playing a key role as both a regional and world leader have largely become ingrained in the national consciousness and transcend party politics.

Economically, Brazil has established a solid foundation for steady growth based on political stability and an incremental reform process. The growing consensus for responsible fiscal and monetary policy is likely to lessen the disruptions from crises that have plagued the country in the past. Dramatic departures from the current economic consensus in Brazil, either a radical turn toward a free-market and free trade-oriented economic model or a heavy-handed statist orientation, appear to be unlikely by 2025.

Brazil's recent preliminary finds of new, possibly large offshore oil deposits have the potential to add another dynamic to an already diversified economy and put Brazil on a more rapid economic growth path. The oil discoveries in the Santos Basin—potentially holding tens of billions of barrels of reserves—could make Brazil after 2020 a major oil exporter when these fields are fully exploited. Optimistic scenarios, which assume a legal and regulatory framework attractive to foreign investment, project oil rising to a 15 percent share of GDP by 2025; even then, petroleum would only complement existing sources of national wealth.

"The oil discoveries in the Santos Basin—potentially holding tens of billions of barrels of reserves—could make Brazil after 2020 a major oil exporter…"

Progress on social issues, such as reducing crime and poverty, will likely play a decisive role in determining Brazil's future leadership status. Without advances in the rule of law, even rapid economic growth will be undercut by the instability that results from pervasive crime and corruption. Mechanisms to incorporate a growing share of the population into the formal economy also will be needed to buttress Brazil's status as a modernizing world power.

Up-and-Coming Powers

Owing to the large populations and expansive landmasses of the new powers like India and China, another constellation of powerhouses is unlikely to erupt on the world scene over the next decade or two. However, up-and-coming developing states could account for an increasing proportion of the world's economic growth by 2025. Others also will play a dynamic role in their own neighborhoods.

Indonesia, Turkey and a post-clerically run **Iran—**states that are predominantly Islamic, but which fall outside the Arab core—appear well-situated for growing international roles. A growth-friendly macro-economic policy

climate would allow their natural economic endowments to flourish. In the case of Iran, radical political reform will be necessary.

Indonesia's performance will depend upon whether it can replicate its success at political reform with measures to spur the economy. In the past decade, Indonesians have transformed their once-authoritarian country into a democracy, turning the vast archipelago into a place of relative calm where support for moderate political solutions is strong, separatist movements are largely fading away, and terrorists, finding little public support, are increasingly found and arrested. With abundant natural resources and a large population of potential consumers (it is the world's fourth most populous country), Indonesia could rise economically if its elected leaders take steps to improve the investment climate, including strengthening the legal system, improving the regulatory framework, reforming the financial sector, reducing fuel and food subsidies, and generally lowering the cost of doing business.

Looking at **Iran**—a state rich in natural gas and other resources and high in human capital—political and economic reform in addition to a stable investment climate could fundamentally redraw both the way the world perceives the country and also the way in which Iranians view themselves. Under those circumstances, economic resurgence could take place quickly in Iran and embolden a latent cosmopolitan, educated, at times secular Iranian middle-class. If empowered, this portion of the population could broaden the country's horizons, particularly eastward and away from decades of being mired in the Arab conflicts of the Middle East.

Turkey's recent economic track record of increased growth, the vitality of Turkey's emerging middle class and its geostrategic locale raise the prospect of a growing regional role in the Middle East. Economic weaknesses such as its heavy dependence on external energy sources may help to spur it toward a greater international role as Turkish authorities seek to develop their ties with energy suppliers—including close neighbors Russia and Iran—and bolster its position as a transit hub. Over the next 15 years, Turkey's most likely course involves a blending of Islamic and nationalist strains, which could serve as a model for other rapidly modernizing countries in the Middle East.

Global Scenario I: *A World Without the West*

In this fictionalized account, the new powers supplant the West as leaders on the world stage. This is not inevitable nor the only possible outcome of the rise of new states. Historically the rise of new powers—such as Japan and Germany in the late 19th and early 20th centuries—presented stiff challenges to the existing international system, all of which ended in worldwide conflict. More plausible in our minds than a direct challenge to the international system is the possibility that the emerging powers will assume a greater role in areas affecting their vital interests, particularly in view of what may be growing burden fatigue for Western countries.

Such a coalition of forces could be a competitor to institutions like NATO, offering others an alternative to the West. As detailed, we do not see these alternative coalitions as necessarily permanent fixtures of the new landscape. Indeed, given their diverse interests and competition over resources, the newer powers could as easily distance themselves from each other as come together. Although the emerging powers are likely to be preoccupied with domestic issues and sustaining their economic development, increasingly, as outlined in this chapter, they will have the capacity to be global players.

Preconditions for this scenario include:

- Lagging Western growth prompts the US and Europe to begin taking protectionist measures against the faster-growing emerging powers.

- Different models of state-society relationships help underpin the powerful (albeit fragile) Sino-Russia coalition.

- Tensions between the principal actors in the multipolar world are high as states seek energy security and strengthened spheres of influence. The Shanghai Cooperation Organization (SCO), especially, seeks reliable and dependable clients in strategic regions—and Central Asia is in both Russia's and China's backyards.

上海合作组织

The Shanghai Cooperation Organisation

Шанхайскаяорганизациясотрудничества

Letter from Head of Shanghai Cooperation Organization to Secretary-General of NATO

June 15, 2015

I know we meet tomorrow to inaugurate our strategic dialogue, but I wanted to share with you beforehand my thoughts about the SCO and how far we have come. Fifteen to 20 years ago, I would never have imagined the SCO to be NATO's equal—if not (patting myself on the back) an even somewhat more important international organization. Just between ourselves, we were not destined for "greatness" except for the West's stumbling.

I think it is fair to say it began when you pulled out of Afghanistan without accomplishing your mission of pacifying the Taliban. I know you had little choice. Years of slow or no growth in the US and West had decimated defense budgets. The Americans felt overstretched and the Europeans were not going to stay without a strong US presence. The Afghan situation threatened to destabilize the whole region, and we could not stand idly by. Besides Afghanistan, we had disturbing intelligence that some "friendly" Central Asian governments were coming under pressure from radical Islamic movements and we continue to depend on Central Asian energy. The Chinese and Indians were very reluctant to throw their hats into the ring with my homeland—Russia—but they did not have better options. None of us wanted the other guy to be in charge: we were so suspicious of each other and, if truth be told, continue to be.

The so-called SCO "peacekeeping" action really put the SCO on the map and got us off the ground. Before that, it was an organization where "cooperation" was a bit of a misnomer. It would have been more aptly called the "Shanghai Organization of Mutual Distrust." China did not want to offend the US, so it did not go along with Russia's anti-American efforts. India was there to keep an eye on both China and Russia. The Central Asians thought they could use the SCO for their own purpose of playing the neighboring big powers off against one another. Iran's Ahmedi-Nejad would have joined anything with a whiff of anti-Americanism.

Still, even with these operations, the SCO would not have become a "bloc" if it had not been for the rising antagonism shown by the US and Europe toward China. China's strong ties to the US had oddly enough provided Beijing with legitimacy. China also benefited from a strong US presence in the region; Beijing's Asian neighbors would have been much more worried about China's rise if they had not had the US as a hedge. China and India were content with the status quo and did not want to get into a strong alliance with us Russians for fear of antagonizing the US. As long as that status quo held, the SCO's prospects as a "bloc" were limited.

Then came the growing protectionist movements in the US and Europe led by a coalition of forces from left to right along the political spectrum. Chinese investments came under greater scrutiny and increasingly were denied. The fact that China and India became first adopters of so many new technologies—next generation Internet, clean water, energy storage, biogerontechnology, clean coal, and biofuels—only added to the

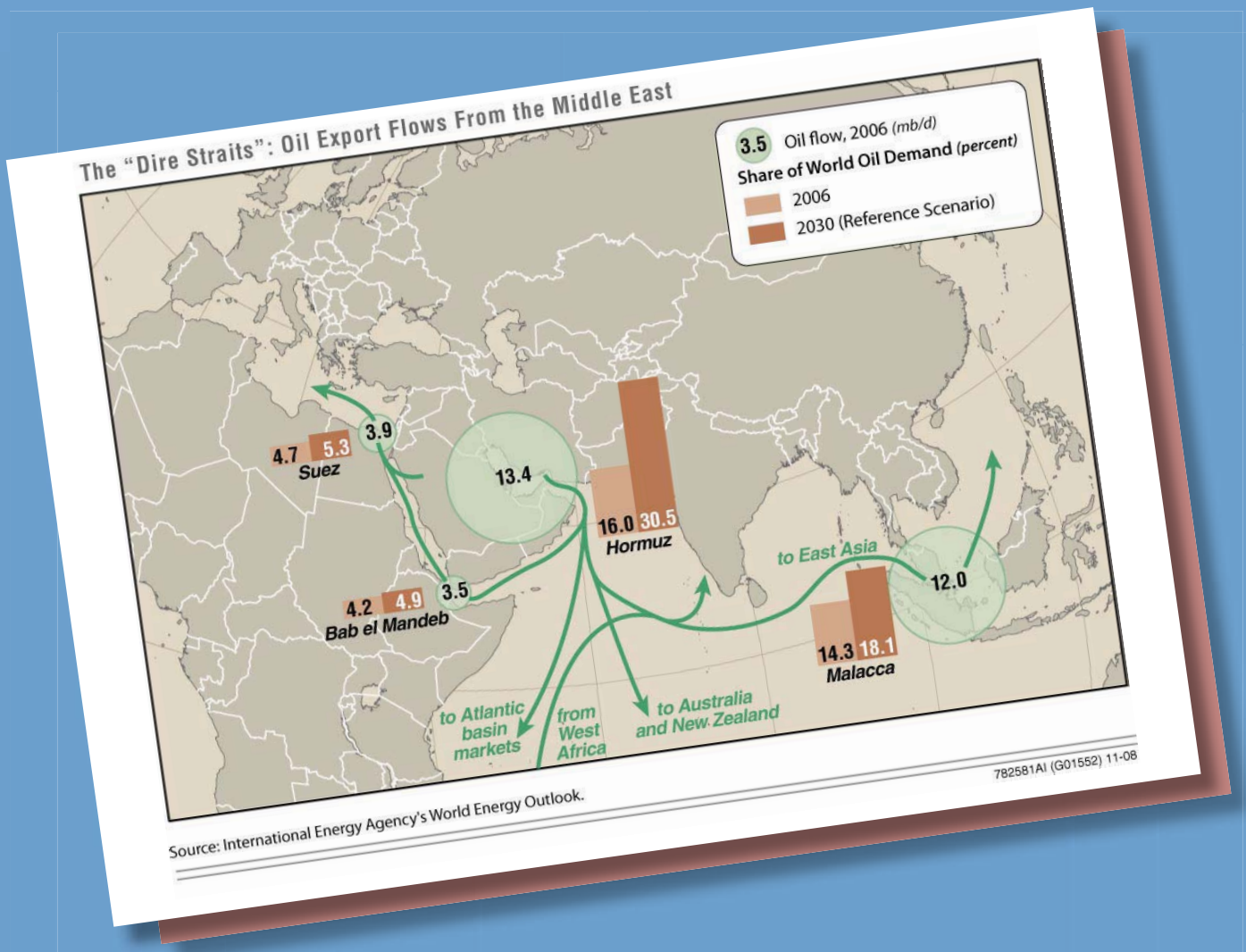
economic-driven frustration. Protectionist trade barriers were put up. Somebody other than “the West” had to pay a price for that recession which dragged on there but not so much elsewhere. China’s military modernization was seen as a threat and there was a lot of loose talk in the West about the emerging powers piggy-backing off the United States’ protection of the sea lanes. Needless to say, the West’s antagonism sparked a nationalistic movement in China.

Interestingly, we Russians watched this from the sidelines without knowing what to do. We were pleased to see our good friends in the West take an economic drubbing. It was still nothing like what we went through in the 1990s and, of course, we took a hit as energy prices sagged with the recession in the West. But we had accumulated a lot of reserves before then.

In the end, these events were a godsend because they forced Russia and China into each other’s arms. Before, Russia had been more distrustful of China’s rise than the United States. Yes, we talked big about shifting all our energy supplies eastward to scare the Europeans from time to time. But we also played China off against Japan, dangling possibilities and then not following through. Our main worry was China. Fears about China’s overrunning Russia’s Far East were a part of it, but I think the bigger threat from our standpoint was of a more powerful China—for example, one that would not forever hide behind Russia’s skirts at the UN. The Soviet-China split was always lurking too. I personally was angered by endless Chinese talk about not repeating Soviet mistakes. That hurt. Not that the Chinese weren’t right, but to admit we had failed when they might succeed—that struck at Russian pride.

But now this is all behind us. Having technology that allowed for the clean use of fossil fuels was a godsend. Whether the West gave it to us, or as we were accused of doing, we stole it, is immaterial. We saw a chance to cement a strong tie—offering the Chinese opportunities for a secure energy supply and less reliance on seaborne supplies from the Middle East. They reciprocated with long-term contracts. We also learned how to cooperate in Central Asia instead of trying to undermine each other by our actions with various regimes. Seeing a strong Sino-Russian partnership arise, the others—India, Iran, etc.—did not want to be left out of the picture and have rallied around us. Of course, it helps that US and European protectionists lumped India with China, so there really was not much left for them to do.

How stable is our relationship? Don’t quote me, but this is not a new Cold War. Sure, we talk a great game about state capitalism and authoritarianism, but it is no ideology like Communism. And it is in our mutual interests that democracy not break out in Central Asia as China and Russia would be the targets of any such uprisings. I can’t say that we Russians and Chinese really like each other much more than before. In fact, both of us have to worry about our respective nationalisms getting in the way of mutual interests. Let’s put it this way: the Russian and Chinese peoples are not enamored with one another. Russians want to be respected as Europeans, not Eurasians, and China’s elites are still in their hearts geared toward the West. But temporary expedients have been known to grow into permanence, you know?



Chapter 4

Scarcity in the Midst of Plenty?

The international system will be challenged by growing resource constraints at the same time that it is coping with the impact of new players. Access to relatively secure and clean energy sources and management of chronic food and water shortages will assume increasing importance for a growing number of countries during the next 15-20 years. Adding well over a billion people to the world's population by 2025 will itself put pressure on these vital resources. An increasing percentage of the world's population will be moving from rural areas to urban and developed ones to seek greater personal security and economic opportunity. Many—particularly in Asia—will be joining the middle class and will be seeking to emulate Western lifestyles, which involve greater per capita consumption of all these resources. Unlike earlier periods when resource scarcities loomed large, the significant growth in demand from emerging markets, combined with constraints on new production—such as the control exerted now by state-run companies in the global energy market—limits the likelihood that market forces alone will rectify the supply-and-demand imbalance.

The already stressed resource sector will be further complicated and, in most cases, exacerbated by climate change, whose physical effects will worsen throughout this period. Continued escalation of energy demand will hasten the impacts of climate change. On the other hand, forcibly cutting back on fossil fuel use before substitutes are widely available could threaten continued economic development, particularly for countries like China whose industries have not yet achieved high levels of energy efficiency. Technological advances and policy decisions around the world germane to greenhouse gas emissions over the next 15 years are likely to determine whether the globe's temperature ultimately rises more than 2 degree centigrade—the threshold at which effects are thought to be no longer manageable.

Food and water also are intertwined with climate change, energy, and demography. Rising energy prices increase the cost for consumers and the environment of industrial-scale agriculture and application of petrochemical fertilizers. A switch from use of arable land for food to fuel crops provides a limited solution and could exacerbate both the energy and food situations. Climatically, rainfall anomalies and constricted seasonal flows of snow and glacial melts are aggravating water scarcities, harming agriculture in many parts of the globe. Energy and climate dynamics also combine to amplify a number of other ills such as health problems, agricultural losses to pests, and storm damage. The greatest danger may arise from the convergence and interaction of many stresses simultaneously. Such a complex and unprecedented syndrome of problems could overload decisionmakers, making it difficult for them to take actions in time to enhance good outcomes or avoid bad ones.

The Dawning of a Post-Petroleum Age?

By 2025 the world will be in the midst of a fundamental energy transition—in terms of both fuel types and sources. Non-OPEC liquid hydrocarbon production (i.e., crude oil, natural gas liquids, and unconventionals such as tar sands) will not be able to grow commensurate with demand. The production levels of many traditional energy producers—Yemen, Norway, Oman, Colombia, the UK, Indonesia, Argentina, Syria, Egypt, Peru, Tunisia—are already in decline. Others' production levels—Mexico, Brunei, Malaysia, China, India, Qatar—have flattened. The number of countries capable of meaningfully expanding production will decline. Only six countries—Saudi Arabia, Iran, Kuwait, the UAE, Iraq (potentially), and

Russia—are projected to account for 39 percent of total world oil production in 2025. The major producers increasingly will be located in the Middle East, which contains some two-thirds of world reserves. OPEC production in the Persian Gulf countries is projected to grow by 43 percent during 2003-2025. Saudi Arabia alone will account for almost half of all Gulf production, an amount greater than that expected from Africa and the Caspian area combined.

A partial consequence of this growing concentration has been increased control of oil and gas resources by national oil companies. When the Club of Rome made its famous forecast of looming energy scarcities, the "Seven Sisters" still had a strong influence on global oil markets and production.[7] Driven by shareholders, they responded to price signals to explore, invest, and promote technologies necessary to increase production. By contrast, national oil companies have strong economic and political incentives to limit investment in order to prolong the production horizon. Keeping oil in the ground provides resources for future generations in oil states that have limited their economic options.

The number and geographic distribution of oil producers will decrease concurrent with another energy transition: the move to cleaner fuels. The prized fuel in the shorter term likely will be natural gas. By 2025, consumption of natural gas is expected to grow by about 60 percent, according to DoE/Energy Information Agency projections. Although natural gas deposits are not necessarily co-located with oil, they are highly concentrated. Three countries—Russia, Iran, and Qatar—hold over 57 percent of the world's natural gas reserves. Considering oil and natural gas together, two countries—Russia and Iran—emerge as energy kingpins. Nevertheless, North America (the US, Canada, and Mexico) is expected to produce an appreciable proportion—18 percent—of total world production by 2025.

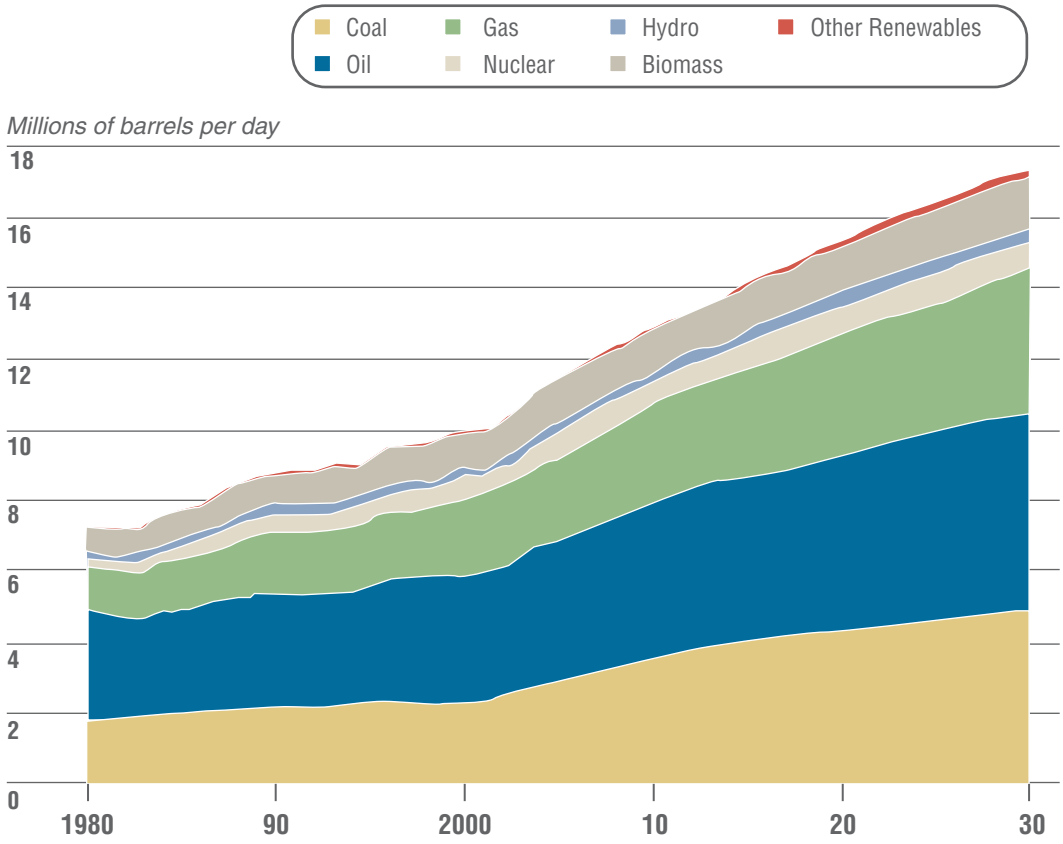
"Aging populations in the developed world; growing resource constraints in energy, food, and water; and worries about climate change are likely to color what will continue to be an historically unprecedented age of prosperity."

Even though the use of natural gas is likely to grow steadily in absolute terms, coal may be the fastest growing energy source despite being the "dirtiest." Rising prices for oil and natural gas would put a new premium on energy sources that are cheap, abundant, and close to markets. Three of the largest and fastest-growing energy consumers—the US, China, and India—and Russia possess the four largest recoverable coal reserves, representing 67 percent of known global reserves. Increased coal production could extend non-renewable carbon-based energy systems for one or even two centuries. China will still be very dependent on coal in 2025 and Beijing is likely to be under increasing international pressure to use clean technologies to burn it. China is overtaking the US in the amount of carbon emissions it puts in the atmosphere despite its much smaller GDP.

The use of nuclear fuel for electrical power generation is expected to expand, but the increase will not be sufficient to fill growing demand for electricity. Third-generation nuclear reactors have lower costs of power

[7] The "Seven Sisters" refers to seven Western oil companies that dominated mid-20th century oil production, refining, and distribution. With the formation and establishment of OPEC in the 1960s and 1970s, the Western oil companies' influence and clout declined.

Breakdown of Likely Energy Sources



Note: Global demand grows by more than half over the next quarter of a century, with coal use rising in absolute terms.

Source: PFC Energy International.

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generation, improved safety characteristics, and better waste and proliferation management features than previous reactor designs. Third-generation nuclear reactors are economically competitive at present electricity prices and are beginning to be deployed around the world. Although most nuclear power plants are currently in industrialized countries, growing demand for electricity in China, India, South Africa and other rapidly growing countries will increase the demand for nuclear power.

The supply of uranium, which is the principal feedstock for nuclear power, is unlikely to limit the future deployment of nuclear power. Available uranium is likely to be sufficient to support the expansion of nuclear energy without reprocessing well into the second half of the century. If uranium should prove to be in short supply, reactors capable of breeding nuclear fuels, along with recycling of used fuels, could continue to support the global expansion of nuclear energy.

However, because of its infrastructure requirements, concern over proliferation of nuclear expertise and material, and uncertainty over licensing and spent fuel

Timing is Everything

All current technologies are inadequate for replacing traditional energy architectures on the scale needed, and new energy technologies probably will not be commercially viable and widespread by 2025 (see foldout). The present generation of biofuels is too expensive to grow, would further boost food prices, and their manufacture consumes essentially the same amount of energy they produce. Other ways of converting nonfood biomass resources to fuels and chemical products should be more promising, such as those based on high-growth algae or agricultural waste products, especially cellulosic biomass. Development of clean coal technologies and carbon capture and storage is gaining momentum and—if such technologies were cost-competitive by 2025—would enable coal to generate more electricity in a carbon-constrained regulatory environment. Long-lasting hydrogen fuel cells have potential, but they remain in their infancy and are at least a decade away from commercial production. Enormous infrastructure investment might be required to support a "hydrogen economy." An Argonne National Laboratory study found that hydrogen, from well to tank, is likely to be at least twice as costly as gasoline.

Even with the favorable policy and funding environment that would be needed for biofuels, clean coal, or hydrogen, major technologies historically have had an "adoption lag." A recent study found that in the energy sector, it takes an average of 25 years for a new production technology to become widely adopted. A major reason for this lag is the need for new infrastructure to handle major innovation. For energy in particular, massive and sustained infrastructure investments made for almost 150 years encompass production, transportation, refining, marketing, and retail activities. Adoption of natural gas, a fuel superior to oil in many respects, illustrates the difficulty of a transition to something new. Technologies to use natural gas have been widely available since at least the 1970s, yet natural gas still lags crude oil in the global market because the technical and investment requirements for producing and transporting it are greater than they are for oil-based fuels.

Simply meeting baseline energy demand over the next two decades is estimated to require more than $3 trillion of investment in traditional hydrocarbons by companies built up over more than a century and with market capitalizations in the hundreds of billions of dollars. Because a new form of energy is highly unlikely to use existing infrastructure without modifications, we expect any new form of energy to demand similarly massive investment.

Despite what are seen as long odds now, we cannot rule out the possibility of a transition by 2025 that would avoid the costs of an infrastructure overhaul. The greatest possibility for a relatively quick and inexpensive transition during that period comes from better renewable generation sources (photovoltaic and wind) and improvements in battery technology. With many of these technologies, the infrastructure cost hurdle for individual projects would be lower, enabling many small economic actors to develop their own energy transformation projects that directly serve their interests—e.g., stationary fuel cells powering homes and offices, recharging plug-in hybrid autos, and selling energy back to the grid. Also, energy conversion schemes—such as plans to generate hydrogen for automotive fuel cells from electricity in a homeowner's garage—could avoid the need to develop complex hydrogen transportation infrastructure. Similarly, non-ethanol biofuels derived from genetically modified feed stocks may be able to leverage the considerable investment in liquid petroleum transport and distribution infrastructure.

processing, expansion of nuclear power generation by 2025 to cover anywhere near the increasing demand would be virtually impossible. The infrastructure (human and physical), legal (permitting), and construction hurdles are just too big. Only at the end of our 15-20 year period are we likely to see a serious ramp up of nuclear technologies.

The Geopolitics of Energy

Both high and low energy price levels would have major geopolitical implications and, over the course of 20 years, periods of both could occur. DoE's Energy Information Administration and several leading energy consultants believe higher price levels are likely, at least to 2015, because of plateauing supply and growing demand. These causes are unlike the case in 1970s and early 1980s when high oil prices were caused by an intentional restriction in supply. Even with the overall secular rise in energy costs, prices well below $100 a barrel are periodically likely with the expected increased volatility and need not come about as a result of technological breakthroughs and rapid commercialization of a substitute fuel. Plausible scenarios for a downward shift and change in market psychology include slowing global growth; increased production in Iraq, Angola, Central Asia, and elsewhere; and greater energy efficiencies with currently available technology.

"With high prices, major exporters such as Russia and Iran would have the financial resources to increase their national power…"

Even at prices below $100 a barrel, financial transfers connected with the energy trade produce clear winners and losers. Most of the 32 states that import 80 percent or more of their energy needs are likely to experience significantly slower economic growth than they might have achieved with lower oil prices. A number of these states have been identified by outside experts as at risk of state failure—the Central African Republic, DROC, Nepal, and Laos, for example. States characterized by high import dependence, low GDP per capita, high current account deficits, and heavy international indebtedness form a particularly perilous state profile. Such a profile includes most of East Africa and the Horn. Pivotal yet problem-beset countries, such as Pakistan, will be at risk of state failure.

With *higher prices*, more stable countries fare better but their prospects for economic growth would drop somewhat and political turbulence could occur. Efficient, service-sector oriented OECD economies are not immune but are harmed the least. China, though cushioned by its massive financial reserves, would be hit by higher oil prices, which would make lifting millions more out of poverty more difficult. China also would need to mine and transport more domestic coal, build more nuclear power plants, and seek to improve energy end-use efficiencies to offset the higher priced imports.

With high prices, major exporters such as Russia and Iran would have the financial resources to increase their national power. The extent and modalities of steps to increase their power and influence would depend on how they used their profits to invest in human capital, financial stabilization, and economic infrastructure. Judicious application of Russia's increased revenues to the economy, social needs, and foreign policy instruments would likely more than double Russia's standing as measured by an academic national power index.

A *sustained plunge in oil prices* would have significant implications for countries relying on robust oil revenues to balance the budget or build up domestic investment. For Iran, a

Winners and Losers in a Post-Petroleum World

We believe the most likely occurrence by 2025 is a technological breakthrough that will provide an alternative to oil and natural gas, but implementation will lag because of the necessary infrastructure costs and need for longer replacement time. However, whether the breakthrough occurs within the 2025 time frame or later, the geopolitical implications of a shift away from oil and natural gas will be immense.

- Saudi Arabia will absorb the biggest shock, as its leaders will be forced to tighten up on the costs of the royal establishment. The regime could face new tensions with the Wahabi establishment as Riyadh seeks to promote a series of major economic reforms—including women's full participation in the economy—and a new social contract with its public as it tries to institute a work ethic to accelerate development plans and diversify the economy.

- In Iran, the drop in oil and gas prices will undermine any populist economic policies. Pressure for economic reform will increase, potentially putting pressure on the clerical governing elite to loosen its grip. Incentives to open up to the West in a bid for greater foreign investment, establishing or strengthening ties with Western partners—including with the US—will increase. Iranian leaders might be more willing to trade their nuclear policies for aid and trade.

For Iraq, emphasis on investing in non-oil sectors of its economy will increase. The smaller Gulf states, which have been making massive investments designed to transform themselves into global tourist and transport hubs, are likely to manage the transition well, bolstered by their robust sovereign wealth funds (SWFs). Across the Arab world, SWFs are being deployed to develop non-oil sectors of the economy in a race against oil as a diminishing asset.

Outside the Middle East, Russia will potentially be the biggest loser, particularly if its economy remains heavily tied to energy exports, and could be reduced to middle power status. Venezuela, Bolivia, and other petro-populist regimes could unravel completely, if that has not occurred beforehand because of already growing discontent and decreasing production. Absent support from Venezuela, Cuba might be forced to begin China-like market reforms.

Early oil decline states—those exporters which had peaked or were declining as is currently the case with Indonesia and Mexico—may be better prepared to shift the focus of their economic activities and diversify into non-energy sectors.

Technology Breakthroughs[a] by 2025

Probable | Possible | Plausible

What Is the Technology?	**Ubiquitous computing** will be enabled by widespread tagging and networking of mundane objects (the Internet of Things) such as food packages, furniture, room sensors, and paper documents. Such items will be located and identified, monitored, and remotely controlled through enabling technologies—including Radio Frequency Identifications, sensor networks, tiny embedded servers, and energy harvesters—connected via the next-generation Internet using abundant, low cost, and high-power computing.	**Clean water technologies** comprise a range of technologies that enable faster and more energy efficient treatment of fresh water and waste water, and desalination of brackish and sea water, to provide sustainable and diverse water sources useable for domestic, agricultural, and industrial purposes. The technologies include advances in existing technologies such as membrane bioreactors and a range of materials' substitutions and advances in other separation and purification technologies driven by the unique chemical and physical properties of nanoparticles and nanofibers.	**Energy storage technology** encompasses a wide range of materials and techniques for storing energy, a necessity for the viability of many alternatives to fossil-fuel energy sources. Included are battery materials, ultracapacitors and hydrogen storage materials (particularly for fuel cells). Efficient energy storage will enable the on-demand energy component of a variety of systems such as hydrogen-based energy systems, a host of renewable (but intermittent) energy sources such as wind and solar, and low-emission transport vehicles.	"**Biogerontechnology**" is the science related to the study of the cellular and molecular basis of disease and aging applied to the development of new technological means for identifying and treating diseases and disabilities associated with old age. Supporting technologies include improvements in biosensors for real-time monitoring of human health, robust information technology, ubiquitous DNA sequencing and DNA-specific medicine, and fully targeted drug-delivery mechanisms.	**Clean coal technologies** include various combinations of carbon capture sequestration (CCS) to prohibit CO2—a byproduct of burning coal—from entering the atmosphere; coal conversion into syngas (gasification); and processes to convert syngas to hydrocarbons. CCS can reduce or possibly eliminate greenhouse gas emissions from a coal plant. Coal gasification improves efficiency when generating electricity and emits fewer pollutants relative to coal burning plants. The syngas also can be a feedstock for transportation fuels and industrial chemicals that replace petroleum-derived products.
What Are Drivers and Barriers?	**Key Drivers:** Demand for greater efficiency in a wide variety of applications from food safety to more efficient supply chains and logistics. Corporations, governments, and individuals will benefit in areas such as energy efficiency and security, quality of life, and early warning of equipment maintenance needs. **Key Barriers:** Implementation depends on availability of power for small, maintenance-free devices, development of profitable business models, and addressing likely major privacy and security concerns.	**Key Drivers:** Clean water is set to become the world's scarcest but most-needed natural resource because of new demands resulting from population increases and expectations that climate changes will reduce natural fresh water sources in some areas. Demand will increase for water for domestic use, as well as for agriculture (including new biopharma and biofuel crops) and industry processes. **Key Barriers:** The demand for sustainable clean water supplies will only be met if both large- and small-scale systems can overcome cost constraints—both in terms of energy requirements and infrastructure costs.	**Key Drivers:** High fossil fuel energy prices, the desire to reduce dependency on foreign energy sources, and pressure to increase renewable energy sources drive the development of these technologies. **Key Barriers:** Development and deployment of the technologies are restricted by material science, the unknown cost of large-scale manufacturing, and infrastructure investment costs.	**Key Drivers:** Aging populations, increasingly expensive medical costs, and the desire to keep older workers in the work force drive the development of these technologies. **Key Barriers:** Cost of development, lengthy human trials, privacy concerns, possible difficulties of insurance, and religious and social concerns will inhibit their development.	**Key Drivers:** The desire to reduce dependence on foreign energy sources drives interest in expanding the use of available coal reserves, while pressure for clean energy production requires development of CCS methods. **Key Barriers:** Substantial technology and cost barriers exist for CCS scale-up and implementation for coal power plants, while uncertainties in both the oil market and environmental regulatory landscape preclude investment in expensive coal gasification plants (even without CCS).
Why Is the Technology a Game-Changer?	These technologies could radically accelerate a range of enhanced efficiencies, leading to integration of closed societies into the information age and security monitoring of almost all places. Supply chains would be streamlined with savings in costs and efficiencies that would reduce dependence upon human labor.	Although the Earth contains a plentiful supply of water, only 1 percent is fit or available for human consumption and some 20 percent of the world's population does not have access to fresh drinking water. Regions experiencing water scarcity will increase as the global population increases and as climate change induced droughts occur. Both developing and developed countries will be affected. Various industries increasingly will compete for water, including agriculture, food, and beverage processing plants as well as chemical, pharmaceutical, and semiconductor industries. First movers to develop and deploy cheap energy-efficient clean-water technologies could gain huge geopolitical advantage.	The ability to store and use energy on demand from a combination of alternative energy sources offers a significant potential to lead a paradigm shift away from fossil fuels, resulting in significant global economic and social advantages to first commercializers. With widespread deployment, the result could be destabilizing to rentier economies dependant upon fossil fuels.	Deployment would shift the cost, allocation, and use of healthcare resources. Nations will be challenged as a result of the changing demographic structures and new psychologies, behaviors and activity patterns of aging yet healthy citizens and the concomitant need to formulate new national economic and social policies.	A successful accelerated and rapid deployment of clean coal technology could pose a major challenge to other hydrocarbon (predominately oil) energy markets and nascent renewable energy markets. This would change the dependency of coal rich/oil poor nations on imported oil/gas with a resulting significant shift in national interests.

[a]These breakthroughs are categorized based upon the development and initial deployment of the technology. In some cases, full deployment may lag significantly due to infrastructure requirements.

Source: SRI Consulting Business Intelligence and Toffler Associates.

Technology Breakthroughs[a] by 2025

Probable | Possible | Plausible

What Is the Technology?	**Human strength augmentation technologies** involve mechanical and electronic systems that supplement human physical capabilities. They include wearable exoskeletons with mechanical actuators at hips, elbows, and other skeletal joints. At the extreme an exoskeleton could resemble a wearable humanoid robot that uses sensors, interfaces, power systems, and actuators to monitor and respond to arm and leg movements, providing the wearer with increased strength and control.	**Biofuels technology** is used to produce ethanol from crops such as corn and sugarcane and biodiesel from crops such as grapeseed and soy. Next-generation processes will convert lignocellulosic materials to fuels. Significant potential also exists to cultivate high-growth microalgae for conversion to biodiesel and other biofuels.	**Service robotics** comprise robots and unmanned vehicles for non-manufacturing applications, using a large number of enabling technologies including hardware (e.g. sensors, actuators, power systems) and software platforms (advanced systems might incorporate behavioral algorithms and artificial intelligence). These technologies would enable a wide variety of remote controlled, semiautonomous (with human intervention), and completely autonomous robotic systems.	**Human cognitive augmentation technologies** include drugs, implants, virtual learning environments, and wearable devices to enhance human cognitive abilities. Training software exploits neuroplasticity to improve a person's natural abilities, and wearable and implantable devices promise to improve vision, hearing, and even memory. Bio and information technologies promise enhanced human mental performance at every life stage.
What Are Drivers and Barriers?	**Key Drivers:** Demand for enhanced strength, endurance, and physical security for assisting the handicapped and elderly, and for reducing reliance on manual labor drive these technologies. **Key Barriers:** The cost of manufacturing and the uncertain economic payoff, challenges with portable power sources, and humans' ability to accept and use the technology all constrain development and deployment of the technologies.	**Key Drivers:** High crude oil prices, the desire to reduce dependency on foreign oil sources, and government policies to increase renewable energy sources drive these technologies. **Key Barriers:** Development and deployment of the technologies are restricted by land use, water availability, competition from food applications, and the challenge of scaling up for large-scale production. Biofuels under development today are more sustainable, but production costs are still too high.	**Key Drivers:** Security and safety applications, healthcare or home care for aging populations, and the desire to improve manufacturing productivity and reduce demand for service labor drive these technologies. **Key Barriers:** Development of viable business models, cost, uncertain technology reach (portable power sources and especially artificial intelligence), and integration issues (e.g. IT, robot standards), inhibit the deployment of service robots.	**Key Drivers:** Desires for improved military planning, combatant performance, treatment of Alzheimer's disease, increasing education effectiveness, enhanced personal entertainment, and improving job performance could spur the development of these technologies. **Key Barriers:** Cultural hesitancy to go down an "unnatural" path of human development, and fears of unknown effects could slow down development and deployment. Major scientific and medical research challenges would need to be overcome.
Why Is the Technology a Game-Changer?	Biomechanical devices promise to give a person superhuman strength and endurance or restore a disabled person's capabilities. The widespread use of the technology would greatly improve labor productivity by reducing the number of humans needed for a task or increasing the amount of work a single human can accomplish, while enabling unassisted activity by the disabled or elderly. Such technologies also could greatly improve the combat effectiveness of ground combat forces.	A large-scale move to energy-efficient biofuels could reduce demand for oil and ease international competition for world oil supplies and reserves. In addition, widespread use of biofuels would fundamentally alter the energy dependence of some nations upon imported fossil fuels thereby shifting national interests. Emerging biofuels technologies that avoid significant land-use changes—using feedstocks such as agricultural waste products, native grasses, and biofuels from algae, could significantly reduce net CO_2 emissions to the atmosphere.	In domestic settings, widespread use of the technology could leverage manpower, disrupt unskilled labor markets and immigration patterns, and change care for a growing elderly population. As early adopters, governments could provide increased security and project combat power with reduced levels of manpower and system life-cycle costs.	The uneven deployment of these technologies could quickly reshape economic and military advantages between nations. Early and robust adopters could see significant benefits, while nations and societies hesitant to employ the technologies may find themselves disadvantaged. International pressure to regulate the technologies could likewise be disruptive as some cultures may welcome the changes to obtain quick benefits, while others loathe their "un-human" character.

[a]These breakthroughs are categorized based upon the development and initial deployment of the technology. In some cases, full deployment may lag significantly due to infrastructure requirements.

Source: SRI Consulting Business Intelligence and Toffler Associates.

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drop in oil prices to the $55-60 range or below would put significant pressure on the regime to make painful choices between subsidizing populist economic programs and sustaining funding for intelligence and security operations and other programs designed to extend its regional power. The notion that state-dominated economies, apparently able to achieve economic growth absent political freedoms or a fully free market, are a credible alternative to Western notions of free markets and liberal democracy could be badly dented, particularly since history suggests the US and other Western states adapt more quickly and effectively to unexpected changes in energy markets.

Under any scenario energy dynamics could produce a number of new alignments or groupings with geopolitical significance:

- Russia, needing Caspian area natural gas in order to satisfy European and other contracts, is likely to be forceful in keeping Central Asian countries within Moscow's sphere, and, absent a non-Russia-controlled outlet, has a good chance of succeeding.

- China will continue to seek to buttress its market power by cultivating political relationships designed to safeguard its access to oil and gas. Beijing's ties with Saudi Arabia will strengthen, as the Kingdom is the only supplier capable of responding in a big way to China's petroleum thirst.

- Beijing will want to offset its growing reliance on Riyadh by strengthening ties to other producers. Iran will see this as an opportunity to solidify China's support for Tehran, which probably would strain Beijing's ties to Riyadh. Tehran may also be able to forge even closer ties with Russia.

- We believe India will scramble to ensure access to energy by making overtures to Burma, Iran, and Central Asia. Pipelines to India transiting restive regions may connect New Delhi to local instabilities.

Water, Food, and Climate Change

Experts currently consider 21 countries with a combined population of about 600 million to be either cropland or freshwater scarce. Owing to continuing population growth, 36 countries, home to about 1.4 billion people, are projected to fall into this category by 2025. Among the new entrants will be Burundi, Colombia, Ethiopia, Eritrea, Malawi, Pakistan, and Syria. Lack of access to stable supplies of **water** is reaching unprecedented proportions in many areas of the world (see map on page 55) and is likely to grow worse owing to rapid urbanization and population growth. Demand for water for agricultural purposes and hydroelectric power generation also will expand. Use of water for irrigation is far greater than for household consumption. In developing countries, agriculture currently consumes over 70 percent of the world's water. The construction of hydroelectric power stations on major rivers may improve flood control, but it might also cause considerable anxiety to downstream users of the river who expect continued access to water.

"Experts currently consider 21 countries, with a combined population of about 600 million, to be either cropland or freshwater scarce. Owing to continuing population growth, 36 countries, home to about 1.4 billion people, are projected to fall into this category by 2025."

The World Bank estimates that demand for food will rise by 50 percent by 2030, as a result of growing world population, rising affluence, and shifts to Western dietary preferences by a larger middle class. The

Two Climate Change Winners

Russia has the potential to gain the most from increasingly temperate weather. Russia has vast untapped reserves of natural gas and oil in Siberia and also offshore in the Arctic, and warmer temperatures should make the reserves considerably more accessible. This would be a huge boon to the Russian economy, as presently 80 percent of the country's exports and 32 percent of government revenues derive from the production of energy and raw materials. In addition, the opening of an Arctic waterway could provide economic and commercial advantages. However, Russia could be hurt by damaged infrastructure as the Arctic tundra melts and will need new technology to develop the region's fossil energy.

Canada will be spared several serious North American climate-related developments—intense hurricanes and withering heat waves—and climate change could open up millions of square miles to development. Access to the resource-rich Hudson Bay would be improved, and being a circumpolar power ringing a major portion of a warming Arctic could be a geopolitical and economic bonus. Additionally, agricultural growing seasons will lengthen, net energy demand for heating/cooling will likely drop, and forests will expand somewhat into the tundra. However, not all soil in Canada can take advantage of the change in growing season, and some forest products are already experiencing damage due to changes in pest infestation enabled by warmer climates.

global food sector has been highly responsive to market forces, but farm production probably will continue to be hampered by misguided agriculture policies that limit investment and distort critical price signals. Keeping food prices down to placate the urban poor and spur savings for industrial investment has distorted agricultural prices in the past. If political elites are more worried about urban instability than rural incomes—a safe bet in many countries—these policies are likely to persist, increasing the risk of tight supplies in the future. The demographic trend for increased urbanization—particularly in developing states—underscores the likelihood that failed policies will continue.

Between now and 2025, the world will have to juggle competing and conflicting energy security and food security concerns, yielding a tangle of difficult-to-manage consequences. In the major grain exporters (the US, Canada, Argentina, and Australia), demand for biofuels—enhanced by government subsidies—will claim larger areas of cropland and greater volumes of irrigation water, even as biofuel production and processing technologies are made more efficient. This "fuel farming" tradeoff, coupled with periodic export controls among Asian producers and rising demand for protein among growing middle classes worldwide, will force grain prices in the global market to fluctuate at levels above today's highs. Some economists argue that, with international markets settling at lower grain volumes, speculation—invited by expectations of rising fuel costs and more erratic, climate change-induced weather patterns—could play a greater role in food prices.

A consortium of large agricultural producers—including India and China, along with the US and EU partners—is likely to work to launch a second Green Revolution, this time in Sub-Saharan Africa, which could help dampen price volatility in worldwide grain markets. By 2025, increases in African grain yields probably will be substantial, but the increases will be confined principally to states in the southern and eastern regions of the continent, which will have deepened trade and security relations with East and South

Strategic Implications of an Opening Arctic

Estimates vary as to when the Arctic is likely to be ice free during the summer. The National Snow and Ice Data Center suggests a seasonally ice-free Arctic by 2060; more current research suggests the date could be as soon as 2013. The two most important implications of an opening Arctic are improved access to likely vast energy and mineral resources and potentially shorter maritime shipping routes.

Transiting the Northern Sea Route above Russia between the North Atlantic and the North Pacific would trim about 5,000 nautical miles and a week's sailing time off a trip compared with use of the Suez Canal. Voyaging between Europe and Asia through Canada's Northwest Passage would trim some 4,000 nautical miles off of a trip using the Panama Canal.

Resource and shipping benefits are unlikely to materialize by 2025. The US National Petroleum Council has said that some of the technology to exploit oil from the heart of the Arctic region may not be ready until as late as 2050. Nonetheless, these potential riches and advantages are already perceptible to the United States, Canada, Russia, Denmark, and Norway—as evidenced by the emergence of competing territorial claims, such as between Russia and Norway, and Canada and Denmark.

Although serious near-term tension could result in small-scale confrontations over contested claims, the Arctic is unlikely to spawn major armed conflict. Circumpolar states have other major ports on other bodies of water, so the Arctic does not pose any lifeblood blockade dangers. Additionally, these states share a common interest in regulating access to the Arctic by hostile powers, states of concern, or dangerous nonstate actors; and by their shared need for assistance from high-tech companies to exploit the Arctic's resources.

The greatest strategic consequence over the next couple of decades may be that relatively large, wealthy, resource-deficient trading states such as China, Japan, and Korea will benefit from increased energy resources provided by any Arctic opening and shorter shipping distances.

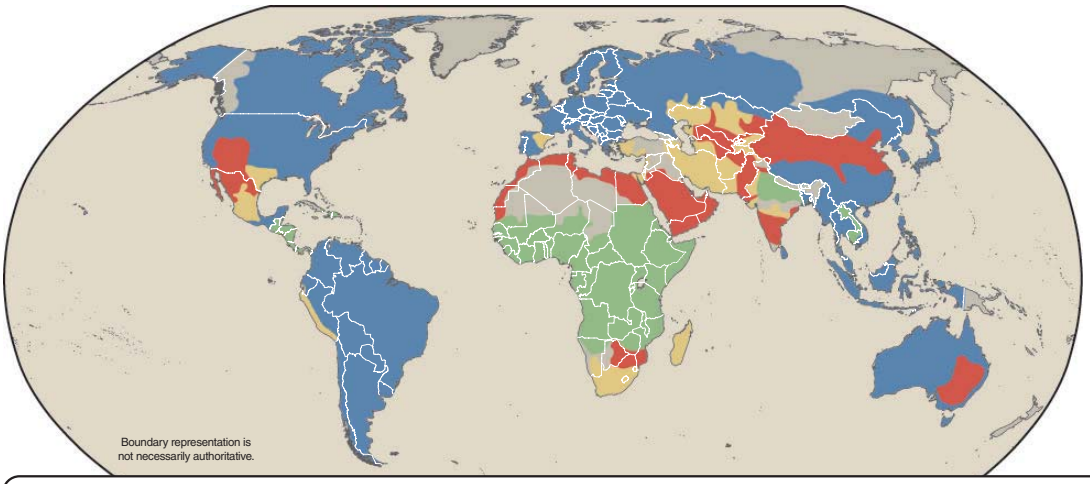
Asian states. Elsewhere south of the Sahara, civil conflict and the political and economic focus on mining and petroleum extraction are likely to foil most of the consortium's attempts to upgrade irrigation and rural transportation networks and to extend credit and investment, allowing population growth to outpace gains in agricultural productivity.

In addition to the currently projected scarcities of freshwater and cropland, the UK Treasury-commissioned Stern Report estimates that by the middle of the century 200 million people may be permanently displaced "climate migrants"—representing a ten-fold increase over today's entire documented refugee and internally displaced populations. Although this is considered high by many experts, broad agreement exists about the risks of large scale migration and the need for better preparation. Most displaced persons traditionally relocate within their home countries, but in the future many are likely to find their home countries have diminishing capabilities to accommodate them. Thus the number of migrants seeking to move from disadvantaged into relatively privileged countries is likely to increase. The largest inflows will mirror many current migratory patterns—from North Africa and Western Asia into Europe, Latin America into the US, and Southeast Asia into Australia.

Over the next 20 years, worries about climate change effects may be more significant than any physical changes linked to climate change. Perceptions of a rapidly changing environment may cause nations to take unilateral actions to secure resources, territory, and other interests. Willingness to engage in greater multilateral cooperation will depend on a number of factors, such as the behavior of other countries, the economic context, or the importance of the interests to be defended or won.

Many scientists worry that recent assessments underestimate the impact of climate change and misjudge the likely time when effects will be felt. Scientists currently have limited capability to predict the likelihood or magnitude of extreme climate shifts but believe—based on historic precedents—that it will not occur gradually or smoothly. Drastic cutbacks in allowable CO_2 emissions probably would disadvantage the rapidly emerging economies that are still low on the efficiency curve, but large-scale users in the developed world—such as the US—also would be shaken and the global economy could be plunged into a recession or worse.

Projected Global Water Scarcity, 2025



Physical water scarcity: More than 75% of river flows are allocated to agriculture, industries, or domestic purposes. This definition of scarcity — relating water availability to water demand — implies that dry areas are not necessarily water-scarce.

Approaching physical water scarcity: More than 60% of river flows are allocated. These basins will experience physical water scarcity in the near future.

Economic water scarcity: Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

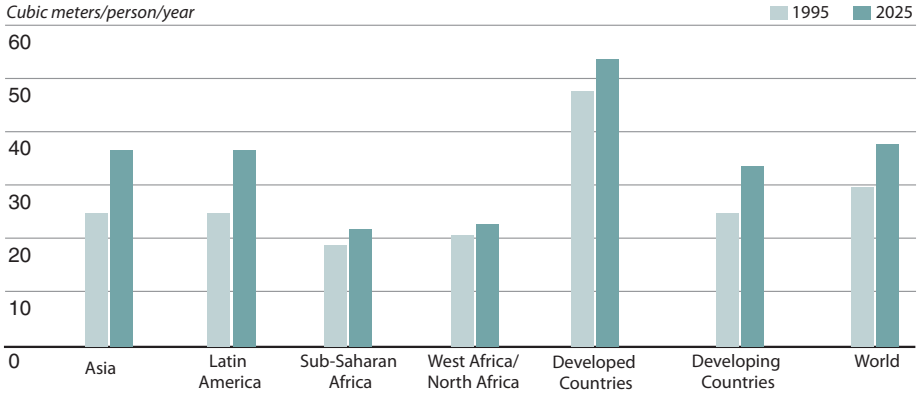
Little or no water scarcity: Abundant water resources relative to use. Less than 25% of water from rivers is withdrawn for human purposes.

Not estimated

Source: International Water Management Institute.

Per Capita Water Consumption, 1995 and 2025

Cubic meters/person/year



Source: International Food Policy Research Institute , Global Water Outlook to 2025.

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Sub-Saharan Africa: More Interactions with the World and More Troubled

In 2025, Sub-Saharan Africa will remain the most vulnerable region on Earth in terms of economic challenges, population stresses, civil conflict, and political instability. The weakness of states and troubled relations between states and societies probably will slow major improvements in the region's prospects over the next 20 years unless there is sustained international engagement and, at times, intervention. Southern Africa will continue to be the most stable and promising sub-region politically and economically.

Sub-Saharan Africa will continue to be a major supplier of oil, gas, and metals to world markets and increasingly will attract the attention of Asian states seeking access to commodities, including China and India. However, despite increased global demand for commodities, increased resource income may not benefit the majority of the population or result in significant economic gains. Poor economic policies—rooted in patrimonial interests and incomplete economic reform—will likely exacerbate ethnic and religious divides as well as crime and corruption in many countries. Ruling elites are likely to continue to accrue greater income and wealth, while poverty will persist or worsen in rural areas and sprawling urban centers. The divide between elite and non-elite populations is likely to widen, reinforcing conditions that could generate divisive political and religious extremism.

By 2025, the region's population is expected to reach over one billion, notwithstanding the effects of HIV/AIDS. Over one-half of the population will be under age 24, and many will be seeking economic opportunity or physical safety via out-migration owing to conflict, climate change, or widespread unemployment. The earliest global effects of climate change, including water stress and scarcity, will begin to occur in Sub-Saharan Africa by 2025.

Today almost one-half (23 of 48) of the countries in Sub-Saharan Africa are classed as democracies, and the majority of African states are on a democratic path, but the most populous states in the region and those with high population growth could backslide.

Although Africa is already assuming more of its own peacekeeping responsibilities, the region will be vulnerable to civil conflict and complex forms of interstate conflict—with militaries fragmented along ethnic or other divides, limited control of border areas, and insurgents and criminal groups preying on unarmed civilians in neighboring countries. Central Africa contains the most troubling of these cases, including Congo-Kinshasa, Congo-Brazzaville, Central African Republic, and Chad.

In contrast to other regions of the world, African attitudes toward the US will remain positive, although many African governments will remain critical of US policies on issues like the Middle East, Cuba, and global trade. Africa will continue to push for UN reform and for permanent representation on the UN Security Council.

Global Scenario II: *October Surprise*

In the following fictionalized account, global inattention to climate change leads to major unexpected impacts, thrusting the world into a new level of vulnerability. Scientists are currently uncertain whether we already have hit a tipping point at which climate change has accelerated and whether there is little we can do—including reducing emissions—that will mitigate effects even over the longer term. Most scientists believe we will not know whether we have hit a tipping point until it is too late. Uncertainties about the pace and specific vulnerabilities or impacts from climate change are likely to persist over the next 15-20 years even if our knowledge about climate change deepens, according to many scientists.

An extreme weather event—as described in this scenario—could occur. Coping with the greater frequency of such events, coupled with other physical impacts of climate change such as growing water scarcities and more food crises, may preoccupy policymakers even while options for solving such problems dwindle. In this example, relocating the New York Stock Exchange to a less vulnerable location is considered, but serious consideration also would be given to relocating other institutions to ensure continuity of operations. Although this scenario focuses on an event that occurs in the US, other governments have been caught by surprise with different types of environmental disasters and have suffered a loss of standing. Mitigation efforts—further cutbacks in carbon emissions—are unlikely to make any difference, at least in the short run, according to this account. Such a world involving potentially major dislocations could threaten both developed and developing countries.

Preconditions assumed in this scenario include:

- Nations adopt a "growth-first" mentality leading to widespread environmental neglect and degradation.
- Governments, particularly those lacking transparency, lose legitimacy as they fail to cope with environmental and other disasters.
- Despite significant technological progress, no technological "silver bullet" is found to halt the effects of climate change.
- National solutions to environmental problems are short term and inadequate.

Presidential Diary Entry
October 1, 2020

The term "October Surprise" keeps recurring in my mind…I guess we had it coming, but it was a rude shock. Some of the scenes were like the stuff from the World War II newsreels, only this time it was not Europe but Manhattan. Those images of the US aircraft carriers and transport ships evacuating thousands in the wake of the flooding still stick in my mind. Why does hurricane season have to coincide with the UNGA in New York? It's bad enough that this had to happen; it was doubly embarrassing that half the world's leaders were here to witness it—and a fair number of them had to be specially airlifted or spirited away for their safety.

I guess the problem was that we counted on this not happening, at least not yet. Most scientists assumed the worst effects of climate change would occur later in the century. Still, enough warned there was always a chance of an extreme weather event coming sooner and, if it hit just right, one of our big urban centers could be knocked out. As I remember, most of my advisors thought the chances were pretty low after the last briefing we got on climate change. But we were warned that we needed to decentralize our energy generation and improve the robustness of our infrastructure to withstand extreme weather events. Tragically, we did not heed this advice.

We'll survive, but Wall Street really has taken a blow and I don't think we will get the NY Stock Exchange back up and running as quickly as we did after 9/11. There is a question whether it will continue to be the NY Stock Exchange to begin with; it might have to change its name to the "Garden State (New Jersey) Stock Exchange"—wouldn't that be a blow to New Yorkers' pride!

It's not as if this is just happening to us. Truth be told, the problem has been our whole attitude about globalization. When I say "our," I really mean in this context the elite or even the little knot of leaders around the world. We all have been focused on boosting or maintaining greater economic growth. We have a lot to be proud of too in that regard. We have avoided giving in to protectionist urges and managed to reenergize the trade rounds. But we have not prepared sufficiently for the toll that irresponsible growth is having on the environment. The New York disaster may not have been preventable with any measures we could have taken 20 years ago, but what are we laying in store for future generations by ignoring the signs? We all assume technology will come to the rescue, but so far we have not found the silver bullet and carbon emissions continue to climb.

What we did not understand is that the general publics in several countries appear to be ahead of leaders in understanding the urgency or at least they have had a better sense of the need for trade-offs. They have become early adopters for energy generation from renewables, the use of clean water technologies, and using improved Internet connectivity to avoid the concentration of people that make them vulnerable to extreme weather events. The Europeans, of course, have been out in the lead on energy efficiency, but they have been too ready to sacrifice growth, and without economic growth, they have not been able to generate high-paying jobs.

In China, it's the opposite—too much crony capitalism. It's not clear, for example, that China's Communist Party (CCP) will survive the scandal over burst dams and the devastation that followed. A couple of decades ago, I would have thought it possible. At that time, the public there was so grateful for the material benefits accruing from China's hell-bent efforts to modernize that the Chinese people forgave the leaders almost everything. Now it is different. The middle class wants clean air and water. They don't like the environmental devastation that was the price of rapid modernization or corruption that winks at the turning off of US provided carbon capture equipment in their coal fired electrical plants. The Party is split too. Half worry about a slowdown from more sustainable, environmentally prudent growth that could be politically devastating if jobs are not generated to the same degree. The other half understands the hardships and is more attuned to changing middle class priorities. I would not be surprised if the 100,000 who perished in the recent dam disaster turn out to be the straw that breaks the CCP's legitimacy, coming as it does on the heels of those corruption allegations against high party officials.

The poorest countries have suffered the most from our hands-off approach to globalization. I know we have talked for some time about not all boats being lifted and the need to do something about it. But I think we thought it best that Bill Gates, NGOs, and others handle the problem. Of course, everyone has to get involved. NGOs can't mount peacekeeping operations. States at some point have to take responsibility. Most of these countries did not have a chance without strong outside intervention. The fact that we had clean water technology and could not find a way to get it delivered to the most needy only made the bad impacts of climate change worse.

With the climate changing rapidly, we are facing more problems—though not insuperable—in maintaining adequate agricultural production. More challenging than boosting agricultural yields overall is that changing weather patterns mean certain areas can't sustain themselves. People migrate to the cities but the infrastructure is insufficient to support such burgeoning populations. This in turn sows the seeds for social conflict which impedes any steps toward good governance and actually digging out from a long downward cycle. I count about 20 countries in this condition.

The problem is that some of these are not small, geopolitically insignificant countries. Some—like Nigeria—we in the developed world rely on for needed resources. Because of the encroaching desertification in the north, the religious clash between Muslims and Christians is heating up. Another Biafra-like civil war—only this time along North-South lines—is not inconceivable.

We talk a lot about these problems at the G-14 summits and in fact have started to engage in joint scenario exercises, but doing anything about an impending storm cloud is still beyond us. My last thought for the diary before I have to greet the dignitaries being airlifted onto the aircraft carrier for the UNGA reception: the growth projection figures are really bad. The cumulation of disasters, needed cleanups, permafrost melting, lower agricultural yields, growing health problems, and the like are taking a terrible toll, much greater than we anticipated 20 years ago.

Chapter 5

Growing Potential for Conflict

We now assess the potential for conflict—both interstate and intrastate—over the next 15-20 years to be greater than we anticipated in ***Mapping the Global Future***, particularly in the greater Middle East. Large parts of the region will become less volatile than today and more like other parts of world, such as East Asia, where economic goals predominate, but other portions of the region remain ripe for conflict. The combination of increasingly open economies and persistently authoritarian politics creates the potential for insurgencies, civil war, and interstate conflict. By 2025, Iran's nuclear ambitions are likely to be clear in one way or the other and the region will either be swept up in an arms race or have found another way to try to establish regional security. Although we believe the appeal of al-Qa'ida and other international terrorist groups will diminish over the next 15-20 years, pockets of support will remain, ensuring a continuing threat, particularly as lethal technology is expected to become more accessible.

A Shrinking Arc of Instability by 2025?
In our previous study, ***Mapping the Global Future***, we assessed that those states most susceptible to conflict are in a great arc of instability stretching from Sub-Saharan Africa through North Africa, into the Middle East, the Balkans, the Caucasus, and South and Central Asia, and parts of Southeast Asia. Today, parts of this arc are experiencing increasing economic activity, including moderate to high levels of GDP growth, slow but perceptible economic reform, improved regulatory performance, deepening financial markets, high levels of outside and intra-regional investment and related technology transfers, and development of new trade corridors. In the medium-to-longterm, increased rates of growth are likely to be sustained if energy prices remain high, but not so high that they depress growth in other regions. Awareness of increasing vulnerability to systemic changes in world energy markets also may act as a goad to further economic reform, including greater diversification in energy-rich states.

For regimes, managing economic change will involve a delicate balancing act between the imperatives of fostering economic growth and maintaining authoritarian rule. Although some regimes may succeed, the odds are that only one or two will become genuine democracies and one or two will end up with civil disorder and conflict because rulers miscalculate the tradeoffs or take gambles that don't pay off.

Growing Risk of a Nuclear Arms Race in the Middle East
A number of states in the region are already thinking about developing or acquiring nuclear technology useful for development of nuclear weaponry. Over the next 15-20 years, reactions to the decisions Iran makes about its nuclear program could cause a number of regional states to intensify these efforts and consider actively pursuing nuclear weapons. This will add a new and more dangerous dimension to what is likely to be increasing competition for influence within the region, including via proxies—Shia in Iran's case and Sunnis for most of its neighbors—and a competition among outside powers anxious to preserve their access to energy supplies and to sell sophisticated conventional weaponry in exchange for greater political influence and energy agreements.

Not Inevitable… Historically, many states have had nuclear weapons ambitions but have not gone the distance. States may prefer to retain the technological ability to produce nuclear weapons rather than to develop actual weapons. Technological impediments and a desire to avoid political isolation and seek greater integration into the global economy

A Non-nuclear Korea?

We see a unified Korea as likely by 2025—if not as a unitary state, then in some form of North-South confederation. While diplomacy working to end North Korea's nuclear weapons program continues, the final disposition of the North's nuclear infrastructure and capabilities at the time of reunification remain uncertain. A new, reunified Korea struggling with the large financial burden of reconstruction will, however, be more likely to find international acceptance and economic assistance by ensuring the denuclearization of the Peninsula, perhaps in a manner similar to what occurred in Ukraine post-1991. A loosely confederated Korea might complicate denuclearization efforts. Other strategic consequences are likely to flow from Korean unification, including prospects for new levels of major power cooperation to manage new and enduring challenges, such as denuclearization, demilitarization, refugee flows, and financing reconstruction.

could motivate Tehran to forego nuclear weaponization. However, even an Iranian *capacity* to develop nuclear weapons might prompt regional responses that could be destabilizing.

If Iran does develop nuclear weapons, or is seen in the region as having acquired a latent nuclear weapons capability, other countries in the region may decide *not* to seek a corresponding capability. It is more likely, however, that a few of Iran's neighbors will see Iran's development of nuclear weapons or a latent weapons capability as an existential threat or as resulting in an unacceptable, fundamental shift of power in the region, and therefore will seek offsetting capabilities. Security guarantees from existing nuclear powers that regional states find credible may be regarded by them as a sufficient offset to an Iranian nuclear weapons capability, but it could be a tall order to expect such guarantees to satisfy all of those concerned about a nuclear Iran.

…But Potentially More Dangerous than the Cold War. The prospect that nuclear weapons will embolden Iran, lead to greater instability, and trigger shifts in the balance of power in the Middle East appears to be the key concern of the Arab states in the region and may drive some to consider acquiring their own nuclear deterrent. Iran's growing nuclear capabilities are already partly responsible for the surge of interest in nuclear energy in the Middle East, fueling concern about the potential for a nuclear arms race. Turkey, United Arab Emirates, Bahrain, Saudi Arabia, Egypt, and Libya are or have expressed interest in building new nuclear power facilities. Future Iranian demonstrations of its nuclear capabilities that reinforce perceptions of its intent and ability to develop nuclear weapons potentially would prompt additional states in the region to pursue their own nuclear weapons programs.

"We see a unified Korea as likely by 2025—if not as a unitary state, than in some form of North-South confederation."

It is not certain that the type of stable deterrent relationship that existed for most of the Cold War would emerge naturally in the Middle East with multiple nuclear-weapons capable states. Rather than episodes of suppressing or shortening low-intensity conflicts and terrorism, the possession of nuclear weapons may be perceived as making it "safe" to engage in such activities, or even larger conventional attacks, provided that certain redlines are not crossed. Each such incident between nuclear-armed states, however, would hold the potential for nuclear escalation.

The continued spread of nuclear capabilities in the greater Middle East, where several states will be facing succession challenges over the next 20 years, also will raise new concerns over the capacity of weak states to maintain control over their nuclear technologies and arsenals. If the number of nuclear-capable states increases, so will the number of countries potentially willing to provide nuclear assistance to other countries or to terrorists. The potential for theft or diversion of nuclear weapons, materials, and technology—and the potential for unauthorized nuclear use—also would rise. Finally, enough countries might decide to seek nuclear weapons capabilities in reaction to an Iranian capability that countries beyond the region would begin pursuing their own nuclear weapons programs.

New Conflicts Over Resources?

The rising energy demands of growing populations and economies may bring into question the availability, reliability, and affordability of energy supplies. Such a situation would heighten tensions between states competing for limited resources, especially if accompanied by increased political turbulence in the Middle East and a general loss of confidence in the ability of the marketplace to satisfy rising demands. National companies could control the lion's share of the world's hydrocarbon resources, leading to a further blending of energy-state relationships and geopolitical concerns.

Perceptions of energy scarcity will drive countries to take actions to assure their future access to energy supplies. In the worst case this could lead to interstate conflicts if government leaders deem assured access to energy resources to be essential to maintaining domestic stability and the survival of their regime. However, even actions short of war will have important geopolitical implications as states undertake strategies to hedge against the possibility that existing energy supplies will not meet rising demands. Energy security considerations are already driving countries such as China and India to purchase equity stakes in energy fields, and evolving competitions are increasingly being supported by military capabilities leading to the potential for heightened tensions and even conflict. Energy-deficient states may employ transfers of arms and sensitive technologies and the promise of a political and military alliance as inducements to establish strategic relationships with energy-producing states.

- Central Asia has become an area of intense international competition for access to energy. Although Russia and China currently are working cooperatively to reduce the leverage of outside powers, especially the United States, competition between the two in Central Asia could escalate if in the future Russia seeks to interfere with China's relations in the region or China becomes more aggressive in obtaining its access to energy supplies in parts of the former Soviet Union.

- The future development of novel drilling techniques may create new opportunities to find and exploit previously unexplored ultra-deep oil fields. Such fields, however, may be located in areas of contested ownership, such as Asia or the Arctic, creating the potential for conflict.

Middle East/North Africa: Economics Drives Change, but with Major Risk of Turmoil

The Middle East and North Africa (MENA) will remain a geopolitically significant region in 2025, based on the importance of oil to the world economy and the threat of instability. The region's future will depend on how leaders manage oil windfalls, demographic changes, pressure for political change, and regional conflicts.

In a positive scenario in which economic growth becomes increasingly rooted and sustained, regional leaders will choose to invest in the region; implement economic, educational, and social policies that encourage more growth; move forward with political reform that empowers moderate—and probably Islamic—political parties; work to settle regional conflicts; and implement security agreements that help prevent future instability.

- In a more negative scenario, leaders will fail to prepare their growing populations to participate productively in the global economy, authoritarian regimes will hold tightly to power and become more repressive, and regional conflicts will remain unresolved as population growth strains resources.

Demographically, a number of Middle Eastern and North African countries are positioned where Taiwan and South Korea were before their takeoff in the 1960s and 1970s. Over the next 15 or so years, the proportion of the economically active populations (ages 15-64) in countries like Egypt will exceed that of the economically dependent population by a much greater amount than in any other region. This differential provides an opportunity to accelerate economic growth if governments put appropriate economic and social policies in place. Prospects are best in the North African and Gulf states.

- Foreign investment—much of it originating from within the region—will increase integration between Arab economies and drive private-sector development. The most promising industries for job growth are likely to be in services, putting the region on a different developmental path than East Asia.

- To maximize growth potential, MENA governments will need to improve their educational systems to produce a more technically skilled work force and encourage citizens accustomed to public sector jobs to accept the demands and volatility of the private sector. (East Asian economies prospered because of sustained government efforts to improve rapidly the quality of the work force through universal education and by developing export industries.)

In other regions, integrating young adults into the work force—coupled with a declining birth rate and shrinking youth bulge—has provided an opening for democratization. Social scientists have found that, as an increasing proportion of the population had a stake in the system, formerly authoritarian states like South Korea and Taiwan felt they could experiment with political liberalization. An important cluster of North African countries—Algeria, Libya, Morocco, Egypt, and Tunisia—has the potential to realize such a demographic-democratic nexus in the period to 2025, but it is unclear whether these authoritarian regimes will exploit these opportunities to liberalize. *(Continued on next page…)*

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A Two-Tier Muslim World? Although the Western paradigm separating religious and secular authority may still be less compelling to Muslim publics, a greater emphasis on economics and, most importantly, greater participation of women in the work force may spur new forms of progressive Islam. This does not mean that extremist strands will disappear; in the short term they might benefit from unease over the changing role of women and alternative family models. But over time, lower fertility promotes religious and political stability and, if secularization in southern Europe is a guide, modernized versions of Islam could take root by 2025.

The channeling of political dissent into Islamic discourse—a variant of the global revival of religious identity in the aftermath of the Cold War—and states' efforts to manipulate Islamic currents will reinforce the dominance of Islam in Middle Eastern politics and society in 2025. As a result, pressures for greater political pluralism are likely to produce a bigger role for Islamic political parties and a re-thinking of how Islam and politics should interact and influence each other, with considerable political and social turmoil generated in the process.

Even as some states may liberalize, others may fail: youth bulges, deeply rooted conflicts, and limited economic prospects are likely to keep Palestine, Yemen, Afghanistan, Pakistan, and others in the high-risk category. Spillover from turmoil in these states and potentially others increases the chance that moves elsewhere in the region toward greater prosperity and political stability will be rocky. The success of efforts to manage and resolve regional conflicts and to develop security architectures that help stabilize the region will be a major determinant of the ability of states to grow their economies and pursue political reform.

Resolution of the Syrian and Palestinian conflicts with Israel, in particular, would broaden the ideological and political discourse within secular and Islamic circles, undermine a traditional pretext for maintaining large militaries and curtailing freedoms, and help defuse sectarian and ethnic tensions in the region.

Iran's trajectory is also likely to have lasting regional impacts—for good or ill. Iran's fractious regime, nationalist identity, and ambivalence toward the United States will make any transition from regional dissenter toward stakeholder perilous and uneven. Although Iran's aims for regional leadership—including its nuclear ambitions—are unlikely to abate, its regional orientation will have difficulty discounting external and internal pressures for reform. An Iranian perception of greater shared interests with the West in Iraq and Afghanistan, for example, and sustained progress on Arab-Israeli peace that weakens Iranian-Syrian ties and accommodates or sidelines Iran's sub-state allies would provide security incentives and pressures on Iran to adjust its regional role. A political consensus within Iran to develop further its significant economic potential—fueled potentially by a sustained popular backlash against corruption and economic mismanagement and a fall in energy rents—could provide an additional push to shift Iran's factional politics to the left and an incentive for Iran to adjust its policies with a view toward easing US and international sanctions.

Energy Security

Other possible examples of the militarization of energy security include:

States using their control of energy resources as weapons of political coercion and influence. Russia is seeking to position itself to control energy supply and related transportation networks from Europe to East Asia. This would enable Moscow to use its control over energy flows to promote Russian interests and influence.

Threats posed by terrorism and piracy to energy production and transit. Public statements by al-Qa'ida leaders indicate terrorists are interested in striking Persian Gulf oil facilities. The protection of energy pipelines, facilities, and shipping from terrorist attacks will be a key security concern and mission for military forces.

Domestic instability, insurgencies, and conflict within strategic energy-producing and exporting states. Ethnic and political violence and criminal activity currently threaten a large portion of Nigeria's oil production. State failure in a key energy producing country may require military intervention by outside powers to stabilize energy flows.

Concerns about assuring future access to energy supplies also are fostering increased naval competition. Despite the growing number of pipeline projects, in 2025 Asian countries will remain dependent on sea transfers of energy from suppliers in the Middle East. This is raising concerns about the future of maritime security in a zone extending from the Persian Gulf to East and Southeast Asia. Maritime security concerns are providing the rationale for a series of naval buildups and modernization efforts in the region, such as China's and India's development of "blue-water" naval capabilities, to protect critical economic assets and secure access to energy resources. Other national navies in the Middle East and Asia will not be able to replace the US Navy's role in protecting strategic sea lines of communication in 2025, but the buildup of regional naval capabilities could lead to increased tensions, rivalries, and counterbalancing.

- Growing concerns over maritime security may create opportunities for multinational cooperation in protecting critical sea lanes. Mutual suspicions regarding the intentions behind naval build-ups by potential regional rivals or the establishment of alliances that exclude key players would, however, undermine efforts for international cooperation.

- A naval arms race in Asia may emerge in response to China's further development of naval power projection. A naval arms race might also be spurred by "anti-access" capabilities—such as attack submarines and long-range antiship missiles—that become widely viewed as efforts by Beijing to extend its political influence in the region and to deter attempts to cut off China's seaborne energy supplies by threatening mutual disruption of sea trade.

Climate change is unlikely to trigger interstate war, but it could lead to increasingly heated interstate recriminations and possibly to low-level armed conflicts. With water becoming more scarce in several regions, cooperation over changing water resources is likely to be increasingly difficult within and between states, straining regional relations. Such regions include the Himalayan region, which feeds the major rivers of China, Pakistan, India, and Bangladesh; Israel-

Another Use of Nuclear Weapons?

The risk of nuclear weapon use over the next 20 years, although remaining very low, is likely to be greater than it is today as a result of several converging trends. The spread of nuclear technologies and expertise is generating concerns about the potential emergence of new nuclear weapon states and the acquisition of nuclear materials by terrorist groups. Ongoing low-intensity clashes between India and Pakistan continue to raise the specter that such events could escalate to a broader conflict between those nuclear powers. The possibility of a future disruptive regime change or collapse occurring in a nuclear weapon state such as North Korea also continues to raise questions regarding the ability of weak states to control and secure their nuclear arsenals.

In addition to these longstanding concerns, new political-military developments could further erode the nuclear "taboo." The prospect of a nuclear-armed Iran spawning a nuclear arms race in the greater Middle East will bring new security challenges to an already conflict-prone region, particularly in conjunction with the proliferation of long-range missile systems. Furthermore, future acquisition of nuclear weapons by states with weak command and control procedures and safeguards increases the probability of accidental or unauthorized nuclear use.

Future asymmetries in conventional military capabilities among potential rivals might tempt weak states to view nuclear weapons as a necessary and justifiable defense in response to the threat of overwhelming conventional attacks. In such cases, the defending power might try to limit the potential for escalation by employing a nuclear weapon test to signal resolve and deter aggression or by confining the use of nuclear weapons to the defense of its own territory. Options for limited physical destruction attacks such as those that use very low-yield weapons or high-altitude nuclear blasts designed to disrupt an enemy's information networks and systems via an electromagnetic pulse effect could further erode the taboo against nuclear weapon use and prompt reassessments of the vulnerabilities of modern conventional military forces.

If nuclear weapons are used destructively in the next 15-20 years, the international system will be shocked as it experiences immediate humanitarian, economic, and political-military repercussions. How the world would respond over the long-term to another use of nuclear weapons would, however, likely depend on the context in which such weapons were used. Prevailing perceptions regarding whether the use of a nuclear weapon was justified, the level of destructiveness it created, and the future utility of nuclear weapons would drive global reactions regarding counterproliferation and nuclear disarmament.

- A terrorist use of a nuclear weapon or an escalating conflict between two nuclear powers, such as India and Pakistan, would graphically demonstrate the danger of nuclear weapons, prompting calls for global nuclear disarmament and energizing counterproliferation and counterterrorism measures.

A successful nuclear weapon test or use of a nuclear weapon by a state to deter or halt a conventional attack might, on the other hand, enhance the perception of the utility of nuclear weapons in defending territorial sovereignty and increase pressures for proliferation in countries that do not possess a strong conventional military or security guarantees.

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In either case, a future use of nuclear weapons probably would bring about significant geopolitical changes as some states would seek to establish or reinforce security alliances with existing nuclear powers and others would push for global nuclear disarmament. In Europe, for example, divisions could emerge between some countries in Western Europe that support nuclear disarmament and those of Eastern Europe that still might fear Russia's nuclear arsenal.

Palestinian Territories; along the Jordan River (Israel-Jordan) and the Fergana Valley of Central Asia. Such dire scenarios are not inevitable even with worse-than-anticipated climate change impacts, however. Economic development, the spread of new technologies, and robust new mechanisms for multilateral cooperation to deal with climate change may foster greater global collaboration.

Terrorism: Good and Bad News

Terrorism is unlikely to disappear by 2025, but its appeal could diminish if economic growth continues and youth unemployment is mitigated in the Middle East. Economic opportunities for youth and greater political pluralism probably would dissuade some from joining terrorists' ranks, but others—motivated by a variety of factors, such as a desire for revenge or to become "martyrs"—will continue to turn to violence to pursue their objectives.

"For those terrorist groups active in 2025, the diffusion of technologies and scientific knowledge will place some of the world's most dangerous capabilities within their reach."

- In the absence of employment opportunities and legal means for political expression, conditions will be ripe for disaffection, growing radicalism, and possible recruitment of youths into terrorist groups.
- Terrorist and insurgent groups in 2025 will likely be a combination of descendants of long-established groups—that inherit organizational structures, command and control processes, and training procedures necessary to conduct sophisticated attacks—and newly emergent collections of the angry and disenfranchised that become self-radicalized.

As long as turmoil and societal disruptions, generated by resource scarcities, poor governance, ethnic rivalries, or environmental degradation, increase in the Middle East, conditions will remain conducive to the spread of radicalism and insurgencies. Future radicalism could be fueled by global communications and mass media. Increasing interconnectedness will enable individuals to coalesce around common causes across national boundaries, creating new cohorts of the angry, downtrodden, and disenfranchised. In some situations these new networks could act as forces for good by pressuring governments through non-violent means to address injustice, poverty, the impacts of climate change, and other social issues. Other groups, however, could use networks and global communications to recruit and train new members, proliferate radical ideologies, manage their finances, manipulate public opinion, and coordinate attacks.

Why al-Qa'ida's "Terrorist Wave" Might Be Breaking Up

As al-Qa'ida celebrates its 20th birthday, most experts assert that the struggle against it will continue indefinitely, the so called "long war." Other experts who have studied past "waves" of terrorism believe that al-Qa'ida is an "aging" group by terrorist standards and suffers from strategic weaknesses that could cause it to decay into marginality, perhaps shortening the lifespan of the Islamic terrorist wave.

A wave of terror is a cycle of activity—which can last up to 40 years—characterized by expansion and contraction phases: rise, floodtide of violence, and ebb. The wave of terror concept was developed by UCLA Professor David C. Rapoport and provides a basis for the comparative analysis of terrorist movements. In each wave, similar terrorist activities occur in many countries, driven by a common vision—such as anarchism, Marxism, nationalism, or Islamic extremism. ***Terrorist groups who form the crest of each wave usually dissolve before the entire wave does, and their decay contributes to the breaking of the wave.*** Al-Qa'ida's weaknesses—unachievable strategic objectives, inability to attract broad-based support, and self-destructive actions—might cause it to decay sooner than many people think.

Research indicates that terrorists' strategic objectives fail on two fronts. Objectives that pose a threat to the existing political order court tough counterterrorism measures, while objectives that are seen as neither achievable nor relevant to solving problems have little appeal to elites or the general populace. The two primary strategic aims of al-Qa'ida—the establishment of a global Islamic caliphate and the removal of US and Western influence so that "apostate" regimes can be toppled—are clearly threats to many existing Muslim governments and are resulting in stronger counterterrorism measures.

- There is little indication that the vast majority of Muslims believe that such objectives are realistic or that, if they could come to pass, would solve the practical problems of unemployment, poverty, poor educational systems, and dysfunctional governance.

Despite sympathy for some of its ideas and the rise of affiliated groups in places like the Mahgreb, al-Qa'ida has not achieved broad support in the Islamic World. Its harsh pan-Islamist ideology and policies appeal only to a tiny minority of Muslims.

- According to one study of public attitudes toward extremist violence, there is little support for al-Qa'ida in any of the countries surveyed—Algeria, Egypt, Jordan, Kuwait, Lebanon, Morocco, Qatar, Saudi Arabia, United Arab Emirates, and Yemen. The report also found that majorities in all Arab countries oppose jihadi violence, by any group, on their own soil.

- Al-Qa'ida is alienating former Muslim supporters by killing Muslims in its attacks. Recent scholarly research indicates that terrorist groups that kill civilians seldom accomplish their strategic goals. Although determining precisely the number of Muslims worldwide who have died in al-Qa'ida attacks is difficult, examination of available evidence suggests that at least 40 percent of the victims have been Muslims.

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The roughly 40-year cycle of terrorist waves suggests that the dreams that inspire terrorist group members' fathers to join particular groups are not attractive to succeeding generations. The prospect that al-Qa'ida will be among the small number of groups able to transcend the generational timeline is not high, given its harsh ideology, unachievable strategic objectives, and inability to become a mass movement.

In relying almost exclusively on terrorism as a means to achieve its strategic objectives, rather than transforming into a political movement like Hizbollah or Hamas, al-Qa'ida is using a stratagem that rarely is successful. Recent academic research indicates that only 6 percent of terrorist groups active in the last 40 years have achieved their proclaimed strategic objectives. Al-Qa'ida's lack of success in executing attacks against the "far enemy" could portend a period of operational futility leading to increased frustration, decreased organizational élan, and inability to attract new members.

Because history suggests that the global Islamic terrorist movement will outlast al-Qa'ida as a group, strategic counterterrorism efforts will need to focus on how and why a successor terrorist group might evolve during the remaining years of the "Islamic terrorist wave."

On a positive note, support for terrorist networks in the Muslim world appears to be declining. To succeed, terrorist groups need a large number of passive supporters who sympathize with terrorists' objectives. Reducing those numbers is key to lessening the appeal within societies. Analysis of terrorists' communications among themselves indicates they see themselves in a "losing" battle with Western materialistic values. Surveys and analysis of jihadist websites indicate growing popular dissatisfaction with civilian casualties—particularly of fellow Muslims—caused by terrorist actions.

For those terrorist groups active in 2025, the diffusion of technologies and scientific knowledge will place some of the world's most dangerous capabilities within their reach. The globalization of biotechnology industries is spreading expertise and capabilities and increasing the accessibility of biological pathogens suitable for disruptive attacks. Radiological and chemical weapons may also be used by terrorists or insurgents seeking an advantage against opposing security or military forces and to create mass casualties. The proliferation of advanced tactical weapons will increase the potential that they will be used by terrorists. Improved anti-tank guided missiles and other man-portable weapon systems, thermobaric and other advanced explosives, and the spread of cheap sensors and robotics that could be used to create more capable improvised explosive devices illustrate this danger.

Some governments will likely respond to increasing terrorism and internal threats by expanding domestic security forces, surveillance capabilities, and the employment of special operations-type forces. Counterterrorism and counterinsurgency missions increasingly will involve urban operations as a result of greater urbanization. Governments, citing the need for enhanced internal security and their desire to control the influx of unwanted refugees and immigrants, may increasingly erect barricades and fences around their territories to inhibit access. Gated communities will continue to spring up

The Changing Character of Conflict

Conflict will continue to evolve over the next 20 years as potential combatants adapt to advances in science and technology, improving weapon capabilities, and changes in the security environment. Warfare in 2025 is likely to be characterized by the following strategic trends:

The Increasing Importance of Information. Advances in information technologies are enabling new warfighting synergies through combinations of advanced precision weaponry, improving target and surveillance capabilities, enhanced command and control, and the expanding use of artificial intelligence and robotics. Future proliferation of long-range precision weapons will permit a growing number of states to threaten rapid destruction of an adversary's critical economic, energy, political, and military and information infrastructures. The growing importance of information technologies as an enabler of modern warfighting capabilities will make information itself a primary target in future conflicts. By 2025 some states probably will deploy weapons designed to destroy or disable information, sensor, and communication networks and systems including anti-satellite, radiofrequency, and laser weapons.

The Evolution of Irregular Warfare Capabilities. The adoption of irregular warfare tactics by both state and nonstate actors as a primary warfighting approach in countering advanced militaries will be a key characteristic of conflicts in 2025. The spread of light weaponry, including precision tactical and man-portable weapon systems, and information and communication technologies will significantly increase the threat posed by irregular forms of warfare over the next 15-20 years. Modern communication technologies such as satellite and cellular phones, the Internet, and commercial encryption, combined with hand-held navigation devices and high-capacity information systems that can contain large amounts of text, maps, and digital images and videos will greatly enable future irregular forces to organize, coordinate, and execute dispersed operations.

The Prominence of the Non-military Aspects of Warfare. Non-military means of warfare, such as cyber, economic, resource, psychological, and information-based forms of conflict will become more prevalent in conflicts over the next two decades. In the future, states and nonstate adversaries will engage in "media warfare" to dominate the 24-hour news cycle and manipulate public opinion to advance their own agenda and gain popular support for their cause.

The Expansion and Escalation of Conflicts Beyond the Traditional Battlefield. Containing the expansion and escalation of conflicts will become more problematic in the future. The advancement of weapons capabilities such as long-range precision weapons, the continued proliferation of weapons of mass destruction, and the employment of new forms of warfare such as cyber and space warfare are providing state militaries and nonstate groups the means to escalate and expand future conflicts beyond the traditional battlefield.

within many societies as elites seek to insulate themselves from domestic threats.

Afghanistan, Pakistan, and Iraq: Local Trajectories and Outside Interests

Developments in Afghanistan, Pakistan, and Iraq will critically affect regional stability, if not the global order. By 2025, the trajectories of these three states probably will have diverged sharply.

In 2025, **Afghanistan** may still evince significant patterns of tribal interaction and conflict. With the exception of the Taliban interlude, Afghanistan has not experienced strong central authority; centrifugal forces are likely to remain strong even if Kabul increases its sway.

- Western-driven infrastructure, economic assistance, and construction are likely to provide new stakes for local rivalries rather than the basis for a cohesive Western-style economic and social unity.

- Globalization has made opium Afghanistan's major cash crop; the country will have difficulty developing alternatives, particularly as long as economic links for trade with Central Asia, Pakistan, and India are not further developed.

Tribal and sectarian disputes probably will continue to arise, be fought out, and shift constantly in Afghanistan as the various players realign themselves. Outsiders will choose between making temporary alliances to destroy terrorist enemies, gain access to local resources, and advance other immediate interests or more ambitious—and costly—goals.

The future of **Pakistan** is a wildcard in considering the trajectory of neighboring Afghanistan. Pakistan's Northwest Frontier Province and tribal areas probably will continue to be poorly governed and the source or supporter of cross-border instability. If Pakistan is unable to hold together until 2025, a broader coalescence of Pashtun tribes is likely to emerge and act together to erase the Durand Line,[8] maximizing Pashtun space at the expense of Punjabis in Pakistan and Tajiks and others in Afghanistan. Alternatively, the Taliban and other Islamist activists might prove able to overawe at least some tribal politics.

In **Iraq,** numerous ethnic, sectarian, tribal, and local notables will compete to establish and maximize areas of political and social authority, access to resources, and to control the distribution of those resources through their patronage networks.

- By 2025 the government in Baghdad could still be an object of competition among the various factions seeking foreign aid and pride of place, rather than a self-standing agent of political authority, legitimacy, and economic policy.

What happens in Iraq will affect neighbors as well as internal contestants. Iran, Syria, Turkey, and Saudi Arabia will have increasing difficulty staying aloof. An Iraq unable to maintain internal stability could continue to roil the region. If conflict there breaks into civil war, Iraq could continue to provide a strong demonstration of the adverse

[8] The Durand Line is the border between Pakistan and Afghanistan—an artificial division that the Afghan Government does not recognize.

End of Ideology?

We judge that ideological conflicts akin to the Cold War are unlikely to take root in a world where most states will be preoccupied with the pragmatic challenges of globalization and shifting global power alignments. The force of ideology is likely to be strongest in the Muslim world—particularly the Arab core where Islam's diverse expressions will continue to influence deeply social norms and politics as well as serve as a prism through which individuals will absorb the economic and cultural forces of globalization. Increasing religious observance and the failures of secular Arab nationalism will leave Islamic political and social movements best positioned to assert ideological influence over governments and publics in much of the Muslim world over the next 15-20 years.

The ensuing Islamic discourse will be increasingly fluid as the clerical leadership detaches from established seats of learning and traditions of jurisprudence and asserts its own interpretations of the Quran and the Hadith (oral tradition). The trend toward bypassing tradition, aided by the spread of media technologies, will encourage the spread of Salafism (reverence for the earliest period in Islam), including its most radical forms, which risks undermining Western allies in the Muslim world, especially in the Middle East. Nonetheless, the dispersal of religious authority into networks of like-minded thinkers also could set the stage for a revival of innovative perspectives on Islam's relationship to the modern world and provide a counterweight to the radical trend.

The direction of Islam's internal ideological struggle will be determined primarily by local conditions. In countries where economic and demographic trends are favorable and publics and governments opt for the benefits of globalization, there will be strong incentives to revive and broaden Islamic teachings that promote a culture of innovation, scientific learning, political experimentation, and respect for religious pluralism. In those countries that are likely to struggle with youth bulges and weak economic underpinnings—such as in Afghanistan, Nigeria, Pakistan, and Yemen—the radical Salafi trend is likely to gain traction.

consequences of sectarianism to other countries in the region. Alternatively, a stable Iraq could provide a positive example of economic growth and political development.

- All players will look to the United States to guarantee stability, but Tehran will continue to fear US designs for Iran's own regime and sovereignty.
- Public opinion polls likely will continue to suggest popular adherence to being "Iraqi," but the persistence of competing security systems, social organizations, and economic subsistence networks will animate robust local and sectarian identities.

The **Sunnis** will have an interest in the central state only if it provides them with what they judge to be an adequate share of resources largely generated outside their areas of control. Absent this satisfaction, agitation by Sunni jihadists, tribal leaders, and other notables could remain a destabilizing factor. In addition, any significant increase in the number of Iraqi Sunnis emigrating to Jordan and Syria could jeopardize the stability of those countries.

Shi'a, flush with their newfound primacy, have historically been divided, and personal rivalries among the Sadrs, Hakims, and other Shi'a notables are likely to continue to color politics in this community. Tribes of mixed Sunni-Shi'a ethnicity could serve as an integrating intercommunal glue, but only if economic development leads to a more transparent and trustworthy central administration and national system for material production and distribution.

Development of a well-integrated national army would be an important factor in maximizing prospects for a more functional Iraqi state. This would require replacing the current tribal and sectarian loyalties of officers and troops with a much more robust sense of corporate élan and national purpose.

Potential Emergence of a Global Pandemic

The emergence of a novel, highly transmissible, and virulent human respiratory illness for which there are no adequate countermeasures could initiate a global pandemic. If a pandemic disease emerges by 2025, internal and cross-border tension and conflict will become more likely as nations struggle—with degraded capabilities—to control the movement of populations seeking to avoid infection or maintain access to resources.

The emergence of a pandemic disease depends upon the natural genetic mutation or reassortment of currently circulating disease strains or the emergence of a new pathogen into the human population. Experts consider highly pathogenic avian influenza (HPAI) strains, such as H5N1, to be likely candidates for such a transformation, but other pathogens—such as the SARS coronavirus or other influenza strains—also have this potential.

If a pandemic disease emerges, it probably will first occur in an area marked by high population density and close association between humans and animals, such as many areas of China and Southeast Asia, where human populations live in close proximity to livestock. Unregulated animal husbandry practices could allow a zoonotic disease such as H5N1 to circulate in livestock populations—increasing the opportunity for mutation into a strain with pandemic potential. To propagate effectively, a disease would have to be transmitted to areas of higher population density.

Under such a scenario, inadequate health-monitoring capability within the nation of origin probably would prevent early identification of the disease. Slow public health response would delay the realization that a highly transmissible pathogen had emerged. Weeks might pass before definitive laboratory results could be obtained confirming the existence of a disease with pandemic potential. In the interim, clusters of the disease would begin to appear in towns and cities within Southeast Asia. Despite limits imposed on international travel, travelers with mild symptoms or who were asymptomatic could carry the disease to other continents.

Waves of new cases would occur every few months. The absence of an effective vaccine and near universal lack of immunity would render populations vulnerable to infection.[a] In this worst-case, tens to hundreds of millions of Americans within the US Homeland would become ill and deaths would mount into the tens of millions.[b] Outside the US, critical infrastructure degradation and economic loss on a global scale would result as approximately a third of the worldwide population became ill and hundreds of millions died.

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[a] US and global health organizations currently are working to develop vaccines that may prevent or mitigate influenza pandemics. A breakthrough in the next several years could reduce the risk posed by pandemic influenza during upcoming decades.

[b] How fast a disease spreads, how many people become sick, how long they stay sick, the mortality rate, and the symptoms and after-effects will vary according to the specific characteristics of whatever pathogen is responsible for a pandemic. This scenario posits plausible characteristics that fall within a range of possibilities for these variables.

Global Scenario III: *BRICs' Bust-Up*

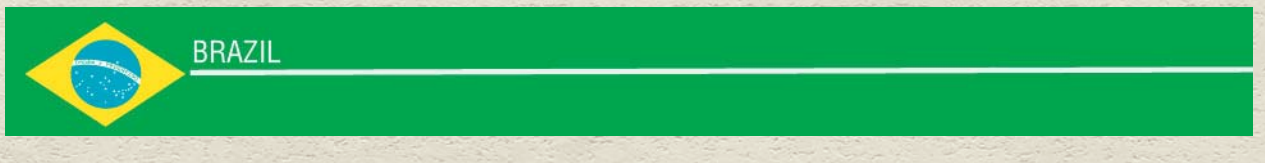
In this fictionalized scenario, Chinese fears of disruption of China's energy supplies spark a clash with India. With increasing resource constraints likely out to 2025, disputes over resources appear to us to be a growing potential source of conflict. The sense of vulnerability is heightened by the dwindling number of energy producers and increasing concentration in unstable regions such as the Middle East. A world in which there are more confrontations over other issues—such as new trade barriers—is likely to increase the potential for any dispute to escalate into conflict. As outlined in this scenario, misperceptions—along with miscommunications—could play as important a role as any actual threats. Also illustrated by this scenario is the competition by rising powers for resources. Both China and India—though rich in coal—have limited and dwindling oil and gas reserves and must rely on foreign sources. In thinking about the increased potential for conflict in this multipolar world, we need to keep in mind the scope for the emerging powers to clash with one another.

Preconditions underpinning this scenario include:

- A steady period of growth has slowed as states struggle to cope with energy and resource shortages, which are particularly acute in the Asian economies.

- A rise in nationalist sentiments occurs with the intense energy competition in this zero-sum world.

- A balance of power emerges that resembles a 21st century replay of the years before 1914.



Letter by current Foreign Minister to former Brazilian President

February 1, 2021

I once heard a story—though I don't know whether it is true—that Goldman Sachs added Brazil as an afterthought to the now-famous grouping of emerging powers or BRICs. Rumor has it that they needed a fourth country, preferably from the southern hemisphere since the others were in the north. It also helped that Brazil began with a B.

True or not, Brazil has pulled its weight over the past six months, performing feats of diplomacy that even the US could not equal in present circumstances.

Let me go back to the beginning even though a lot of this you probably know. In fact, to get to the root of the Sino-Indian clash one has to go back to before there was any news coverage of the events. A lot of little incidents led to the Chinese attack on two Indian warships near the Gulf of Oman, which in turn triggered the US attack disabling the Chinese ships as they tried to withdraw from the area.

For a couple years, the Chinese had been watching what from their standpoint was a dangerous confluence of events that could jeopardize their economic, and therefore political survival. First, the Japanese had been making considerable progress in increasing their sea control capabilities in contested ocean areas that looked promising for producing oil and gas.

Second, there had been a notable acceleration in Indian military modernization as well as Indian attempts to erode Chinese gains in influence in Southeast Asia, increasing India's sea denial capabilities in the areas through which oil and gas move to China from the Middle East. China responded, extending its naval presence in the region by establishing naval basing rights in Pakistan. It became clear that Beijing's strategy was to deter any attempts by India to cut off China's sea access to energy resources by creating a threat to India's sea lanes in return. Tensions between India and China increased sharply when a Chinese submarine disappeared without explanation while monitoring an Indian naval exercise.

Third, Sino-Russian ties were simultaneously taking a tumble despite earlier cooperation in the Shanghai Cooperation Organization. Beijing detected increasing signs of Russia undercutting Chinese relations with Central Asian energy producers. This stoked Chinese energy insecurity. The fact that emerging alternative energy technologies—clean coal, solar, wind, and geothermal—did not materialize after heavy Chinese and US investments did not help.

As you know, even before the Sino-Indian incident, there had been a skirmish or two last year between the Chinese and Russians in Russia's Far East. If the Chinese had feared Russian double-dealing in Central Asia, the Russians were just as paranoid about what the Chinese were up to in Russia's Far East. Russia's accusation of spying by a group of students from Beijing and their subsequent imprisonment in Vladivostok occasioned, as

you well remember, the spectacular Chinese rescue effort which thoroughly humiliated the Russians. Some called it a second Port Arthur in reference to the Japanese sinking the Russian fleet in 1905.

Finally, the strategic competition for influence and access to energy that emerged in the Middle East provided a new backdrop for the increasing rivalry among China, India, and Russia. As the United States reduced its military forces in the Middle East following its involvement in Iraq, the other great powers sought to fill the vacuum. The Gulf Arab states in particular sought to strengthen their relationships with other powers to compensate for what they perceived as a weakened US security commitment post Iraq.

Tensions in the Middle East meanwhile were building as Iran continued to exert its growing power. A crisis erupted after a series of naval incidents between Iranian and Arab naval forces in the Persian Gulf and the Iranian threat to close off access to the Persian Gulf to all naval forces from outside the region except those of “friendly” powers. In response the United States introduced new economic sanctions against Tehran and sought to conduct an embargo of arms shipments to Iran. Tehran countered by threatening to disrupt oil traffic through the Gulf if Washington did not back down.

US pressure on the Chinese, Indians, and others to reject Iranian blandishments and eschew trade with the Iranians was intense. Beijing, fearing a disruption of its energy supplies, sought to play both sides, maintaining good relations with the Saudis while also promising Iran its support. China had established years back a strategic reserve, but that would last only so long and the uncertainty about what happened after a couple months was putting political pressure on the government. New Delhi also sought to nuance its response noting its need for natural gas from Iran but also seeking to maintain its good relationships with the United States and the Arab states. As a result, India declined to participate in economic sanctions that were deemed to be most harmful to ordinary Iranian citizens but agreed to help the United States enforce an arms embargo of Iran.

You can see how this set the stage for the incident at sea. Chinese nerves were on edge, but the Chinese were feeling very confident after the Russian Far East affair. The Indian attempt to stop a Chinese vessel believed to be carrying new antiship cruise missiles to Iran was resisted by Chinese naval forces in the area. The Chinese saw the Indian warships as surrogates for the United States. The US attack confirmed it. The original crisis in the Middle East—which really pitted the US and Europe against Iran—was suddenly transformed into a serious global one.

Fortunately over the past few weeks, unlike 1914, all the powers drew back from the brink. But oil is now over $300 a barrel and stock markets are tanking everywhere. That gets me to the Brazilian angle. We were the only country of any stature that had the trust of all the others. Even the Europeans were discredited because of their links to the US in the Iranian crisis. China was desperate to find a way out of what could have been an even worse position if a full-scale conflict with the Indians and the United States had ensued. The US too wanted a face-saving way out of the impasse since it looked like the only victor would be the Iranians and to an extent the Russians who sat smugly on

the sidelines, reaping a fortune from the spike in energy prices. Of course, our continued development of biofuels in a responsible way only added to our credibility.

In the negotiations, I have tried to do more than just get all sides to back off and pay compensation to one another for the damages to each others' fleets. China needs to be assured about energy flows from the Gulf—at least once they resume.

I'm not sure that I have succeeded in building up mutual confidence and trust. I sense that the militaries in all three places—the US, China, and India—will use the incident to push for greater militarization of energy security. We could experience a new naval arms race.

In China, the government still fears public retribution because of the humiliation suffered by the US attack. Of course, for the moment, the US is the target of the nationalistic outburst—the United States' new embassy is a charred ruin. The Iranians have let up some, particularly as the US and its European partners made some concessions to get the oil flowing again and defuse the crisis with China and India.

I've told the three—the US, India, and China—that the next round of talks has to be held here in Rio. I'm hoping a more convivial atmosphere will do the trick. Rio Carnival is around the corner…

Chapter 6

Will the International System Be Up to the Challenges?

The trend toward greater diffusion of authority and power occurring for a couple decades is likely to accelerate because of the emergence of new global players, increasingly ineffective institutions, growth in regional blocs, advanced communications technologies, and enhanced strength of nonstate actors and networks.

- By 2025, nation-states will no longer be the only—and often not the most important—actors on the world stage and the "international system" will have morphed to accommodate the new reality. But the transformation will be incomplete and uneven. Although states will not disappear from the international scene, the ***relative power*** of various nonstate actors—including businesses, tribes, religious organizations, and even criminal networks—will grow as these groups influence decisions on a widening range of social, economic, and political issues.

The growing multiplicity of actors could strengthen the international system by filling gaps left by aging post-World War II institutions, but it also has the potential to further fragment the existing system and to impede international cooperation. The diversity in both types and kinds of actor increases the likelihood of fragmentation over the next two decades given the apparently waning ability of legacy international institutions to address new transnational challenges.

Multipolarity without Multilateralism

In such a world, we are unlikely to see an overarching, comprehensive, unitary approach to global governance. Current trends suggest that global governance in 2025 will be a patchwork of overlapping, often ad hoc and fragmented efforts, with shifting coalitions of member nations, international organizations, social movements, NGOs, philanthropic foundations, and companies.

- This fragmentation of interests and actors will further erode prospects for the United Nations to strengthen consensus among its members for effective multilateral action—particularly within the current or an expanded Security Council—or for sustaining broader reforms of the UN system.

- This multipolarity is also unlikely to include a single dominant nation-state with the overwhelming power and legitimacy to act as the agent of institutional overhaul. (See below for discussion of the role of the US.)

Most of the pressing transnational problems—including climate change, regulation of globalized financial markets, migration, failing states, crime networks, etc.—are unlikely to be effectively resolved by the actions of individual nation-states. The need for effective global governance will increase faster than existing mechanisms can respond. Leaders will pursue alternative approaches to solving transnational problems—with new institutions, or more likely, many informal groupings. Recent trends suggest that existing multilateral institutions—which are large and cumbersome—will have difficulty adapting quickly enough to undertake new missions, accommodate changing memberships, and obtain necessary resources. NGOs and philanthropist foundations—concentrating on specific issues—increasingly will be a part of the landscape but are likely to be limited in their ability to effect change in the absence of concerted efforts by multilateral institutions or governments.

Quests for greater inclusiveness—to reflect the emergence of newer powers—may make it harder for international organizations to

tackle transnational challenges. Respect for the dissenting views of member nations will continue to shape the agenda of organizations and limit the kinds of solutions possible. Large and enlarging organizations—from the UN General Assembly to NATO and the EU—may find the challenges to be particularly difficult. There is unlikely to be any effort to "zero base" the international organizational structure such that some organizations go away or are reinvented.

Effective action also may be impeded by the existence of too many institutions—many of which have declining purpose—with limited legitimacy and effectiveness. This is likely to apply across the board, from Western-driven institutions to those of the historic Third World.

We anticipate that arms races, territorial expansion, and military rivalries that characterized late 19th century multipolarity will be less significant in the emerging one, but we cannot rule out such possibilities. For most countries, strategic rivalries are likely to revolve around trade, investment, technology innovation, and acquisition. However, increasing worries about resources—such as energy or even water—could easily put the focus back on territorial disputes or unresolved border issues.

Asia is one region where the number of such border issues is particularly noteworthy or, in the case of Central Asia, where large deposits of energy resources increase the potential for a repeat of the 19th century's "Great Game" with outsiders contending for the exclusive right to control market access. The fact that a number of countries may experience a sharp fall in national power if alternatives for fossil fuel are developed quickly injects a potentially dangerous risk of instability. As the national power of China, India, and others grows, smaller countries in the neighborhood may seek outsiders' protection or intervention in a balancing effort.

How Many International Systems?

The emerging powers, particularly China and India, have a shared interest in maintaining a stable and open order, but they espouse different "means." Their spectacular economic success has been achieved with an economic model that is at odds with the West's traditional laissez faire recipe for economic development. As we have seen, climate change, energy, and other resource needs are likely to be more problematic for what many see as their primary goal of continued economic development. Given these differing perspectives, the question arises as to whether the new players—and their alternative approaches—can be melded with the traditional Western ones to form a cohesive international system able to tackle the increasing number of transnational issues.

While sharing a more state-centric view, the national interests of the emerging powers are diverse enough, and their dependence on globalization compelling enough, that there appears little chance of an alternative bloc forming among them to directly confront the more established Western order. The existing international organizations—such as the UN, WTO, IMF, and World Bank—may prove sufficiently responsive and adaptive to accommodate the views of emerging powers, but whether the emerging powers will be given—or will want—additional power and responsibilities is a separate question. Indeed some or all of the rising powers may be content to take advantage of the institutions without assuming leadership burdens commensurate with their status. At the same time, their membership does not necessarily have to involve heavy responsibilities or burden-sharing, allowing them to pursue their goals of economic development. For some, the fact that agreement on new permanent

Greater Regionalism—Plus or Minus for Global Governance?

One exception to the trend toward greater multipolarity with less multilateralism may occur on a regional level in Asia. Greater Asian integration, if it occurs, could fill the vacuum left by a weakening multilaterally based international order but could also further undermine that order. In the aftermath of the 1997 Asian financial crisis, a remarkable series of pan-Asian ventures—the most significant being ASEAN + 3—began to take root. Although few would argue that an Asian counterpart to the EU is a likely outcome even by 2025, if 1997 is taken as a starting point, Asia arguably has evolved more rapidly over the last decade than the European integration did in its first decade(s). In the economic realm, extra-regional players such as the US will continue to be a significant part of the 2025 Asian economic equation. However, movement over the next 15 years toward an Asian basket of currencies—if not an Asian currency unit as a third reserve—is more than a theoretical possibility.

- Such a development would be in part an effort by Asians to insulate themselves from financial volatility outside their region, facilitate economic integration, and to achieve greater representation at the global table.

- Aspects of Asian regionalism that are difficult to quantify include the growing habits of cooperation, buoyant confidence, frequency of encounters by a host of high-level officials and the cultural diffusion that is bridging historical and political differences and is engendering a new sense of community.

Asian regionalism would have global implications, possibly sparking or reinforcing a trend toward three trade and financial clusters that could become quasi-blocs (North America, Europe, and East Asia).

Establishment of such quasi-blocs also would have implications for the ability to achieve future global World Trade Organization agreements and regional clusters could compete in the setting of trans-regional product standards for IT, biotech, nanotech, intellectual property rights, and other "new economy" products.

An Asian regional energy posture could set the terms for the rest of the world. Some two-thirds of Mideast oil exports go to Asia, and some 70 percent of Asian imports are from the Middle East. This pattern is likely to intensify. Whether this nexus is primarily commercial—complementary investments and military sales—or acquires an increasingly political/strategic character could determine the character of the international system.

- As stated, in the worst case—absent greater regional cooperation—concern over oil supply routes could lead to a China-Japan-India naval arms race.

Developments in the security realm—where Asian integration is currently weakest and where trends toward competition and hedging persist—could dilute regionalism. Whether and how Korea is reunified and the status of its nuclear program, and whether Taiwan's relationship to the Mainland moves toward conflict or is resolved peacefully, will be key factors shaping regional

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dynamics. Current trends suggest traditional security concerns are declining in importance but may be replaced by new issues, such as competition over resources. Managing and adjusting to a transition to a reunified Korea could expand the Six-Party talks into a mechanism that features new levels of cooperation among the US, Japan, and China.

Whether greater or lesser integration occurs also depends largely on the future character of Sino-Japanese ties. This is the first time in modern history that China and Japan have been major regional and global actors at the same time. A key question is whether they can transcend historical suspicions and compete peacefully. Peaceful resolution of the Korea and Taiwan disputes and a Franco-German type entente between China and Japan would sharply diminish the regional desire for a US "offshore" balancer role. However, US allies and security partners in the region will not trade in the US balancing role for any collective regional security arrangement until the political and economic consequences of China's rise become better known.

members of the Security Council appears remote even over the next 15-20 years provides an additional excuse to forego a global role which could come at the expense of domestic goals. One large uncertainty is whether the political will exists to reshape the international system to offer the emerging powers enough responsibility for them to shoulder more global burdens.

"Most experts…do not expect the rising powers to challenge or radically alter the international system…"

Most experts—US and foreign—we consulted do not expect the rising powers to challenge or radically alter the international system as did Germany and Japan in the 19th and early 20th centuries. The emerging powers will have a high degree of freedom to "customize" their political and economic policies rather than fully adopting Western norms. Because of their growing geopolitical clout, domestic markets, and roles in global resource extraction, manufacturing, finance, and technology, the rising powers are also likely to want to preserve their policy freedom to maneuver and will want others to carry the burden of dealing with global challenges such as terrorism, climate change, proliferation, and energy security. Russia's and China's resource nationalism and state capitalism underpin, for example, their elite-based politics and limit their willingness to compromise on major international economic issues such as trade, energy, finance, or climate change.

- Others, such as India, lack strategic economic and political visions and do not possess domestic grassroots support for deep economic liberalization. Many global issues require sacrifices or abrupt changes to these countries' development plans, another reason for them to prefer to be bystanders rather than leaders in a multilateral system.

A World of Networks

In response to likely deficits in global governance, networks will form among states and nonstate actors focused on specific issues. These networks will operate to pursue convergent goals and interests, including a genuine intent to solve problems, business self-interest, moral grounds, and the desire of

international organizations and NGOs to be relevant to the problems facing a changing world. In some cases, the nucleus of an issue network will be a national or international commission or body of experts—unelected but with substantial clout—to report on or oversee some aspects of governance, trade, or other issues. Current examples of such networks include the Financial Stability Forum, the Carbon Sequestration Leadership Forum, and the International Partnership for the Hydrogen Economy.

Issue groups likely will help develop and diffuse standards and regulations for various realms, including information technology (IT), regulatory regimes, and management of the "new post-industrial economy." For some kinds of issues, the networks likely will provide the basis for agreement among nation-states. With the groundwork done in informal contexts, nation-states will be able to adopt problem-solving measures, gaining legitimacy and sometimes taking credit for initiatives, while avoiding the stigma of solutions being imposed by external international organizations. The numbers and types of NGOs could well explode by 2025. Low entry costs, low overhead, and the capacity of individuals and groups to affiliate with each other using the Internet will facilitate such collectives.

In addition to such issue groups, a new set of social actors—super-empowered individuals and even criminal networks—increasingly will influence outcomes. These elites are empowered by their wealth and an array of national and transnational contacts—oftentimes spanning businesses, governments, international organizations, and NGOs. Using their broad contacts and multiple national identities, they help leverage "transnational" outcomes across national and organizational boundaries.

"Although religious groups have been a great beneficiary of globalization, religion also has the potential to be a primary vehicle for opposition to that same modernizing process."

A Growing Role for Religion. Religion-based networks may be quintessential issue networks and overall may play a more powerful role than secular transnational groupings in exerting influence and shaping outcomes in the period out to 2025. Indeed, we could be entering a new age of clerical leadership in which religious leaders become major power brokers in resolving future international disputes and conflicts.

- Rich rewards in power and influence already fall to those religious entrepreneurs and televangelists who span the two hemispheres, the Global South and North—Amir Khalede for Muslims and Matthew Ashimolowo or Sunday Adelaja for Christians. Khalede's website is the third most popular Arabic website in the world (al-Jazeera's is number one).

Within the Christian tradition, the emergence of whole new patterns of authority and leadership across the Global South entails autonomous ministers and religious entrepreneurs, whose activities reap high status and great wealth. Before 2025, some evangelists and megachurch preachers probably will seek to become the leaders of nations, especially if those countries have been economically devastated during a global downturn.

Although religious groups have been a great beneficiary of globalization, religion also has the potential to be a primary vehicle for opposition to that same modernizing process. Religious structures can channel social and political protest, especially for those who lack the means of communication and influence

Proliferating Identities and Growing Intolerance?

One aspect of the growing complexity of the international system is that no single political identity—such as the conflation of citizenship and nationality—is likely to be dominant in most societies by 2025. Class struggles will matter as much as religion and ethnicity. The Internet and other multi-media will enable the revitalization of the reach of tribes, clans, and other fealty-driven communities. Explosive urbanization will facilitate the spread of these identities and increase the likelihood of clashes between groups. The increasing numbers of migrants moving to cities from rural areas will coalesce in neighborhoods settled by previous co-ethnics or will find themselves targeted for recruitment by gangs and more complex criminal structures. As these communities coalesce and become "self-governing" or sometimes co-opted by organized crime groups, state and local government will face "no-go" areas in many large cities as has already happened in cities like Sao Paulo and Rio de Janeiro.

Although inherited and chosen layers of identity will be as "authentic" as conventional categories of citizenship and nationality, one category possibly will continue to stand out. Islam will remain a robust identity. Sectarian and other differences within Islam will be a source of tension or worse. The challenge of Islamic activism could produce a more intense backlash of Christian activism. Nigeria, Ethiopia, and other places in Africa will remain battlegrounds in this sectarian struggle. In 2025, notions of multiethnic integration and the value of "diversity" could face a combination of challenges from nationalists, religious zealots, and perhaps some version of a revived Marxist and other class-based or secular ideology.

available to social elites. This is relevant because many of the economic trends that will dominate the next two decades have the potential to drive social fragmentation and popular resentment, including the growing gaps between rich and poor, the urban and rural gulfs in India and China, the vast disparities between nations and regions advantaged or left behind by modernization, and between states able to manage the consequences of globalization and those with governments unable to do so. Religious activists can draw on sacred texts and long historical tradition to frame popular grievances in terms of social justice rhetoric and egalitarianism.

If global economic growth did suffer a severe reverse—akin to the Indonesian crisis of the late 1990s but on a worldwide scale—religiously based rural insurgencies and ethnic struggles probably would ensue in a number of countries including Brazil, India, China, and in much of Africa. If even the moderately severe projections of climate change are correct, the impacts could spur religious conflict through large sections of Africa and Asia. Among the countries at greatest risk of such conflict and scapegoating of minority communities are a number of predominantly Muslim countries with significant Christian minorities (Egypt, Indonesia, and Sudan); predominately Christian states with substantial Muslim minorities (e.g., DROC, Philippines, and Uganda) or finely balanced between Christian and Muslim (Ethiopia, Nigeria, and Tanzania).

If religious structures offer vehicles to resist globalization, they also help people cope with those same forces, enhancing social stability and economic development. Without religious safety nets, the degree of chaos and fragmentation in developing nations would be

Future of Democracy: Backsliding More Likely than Another Wave

We remain optimistic about the long-term prospects for greater democratization, but advances are likely to slow and globalization will subject many recently democratized countries to increasing social and economic pressures that could undermine liberal institutions.

- Ironically, economic setbacks could enhance prospects for movement toward pluralism and greater democratization in China and Russia. The Chinese Communist Party's legitimacy increasingly rests on its ability to ensure greater material wealth for Chinese society. Resentment of elite corruption is already on the rise but may overwhelm the regime in event of a serious economic crisis. The government's standing in Russia would be similarly challenged if living standards fell dramatically.

- Elsewhere surveys have shown democracy having taken root, particularly in Sub-Saharan Africa and Latin America, where opinion views it positively independent of any material benefits. Still, nascent democracies have historically been shown to be unstable to the extent that they lack strong liberal institutions—especially rule of law—which can help support democracy during economic downturns. Case studies suggest widespread corruption is especially threatening because it undermines faith in democratic institutions.

- As we have suggested elsewhere in the text, the better economic performance of many authoritarian governments could sow doubts among some about democracy as the best form of government. The surveys we consulted indicated that many East Asians put greater emphasis on good management, including increasing standards of livings, than democracy. Elsewhere even in many well-established democracies, surveys show growing frustration with the current workings of democratic government and questioning among elites over the ability of democratic governments to take the bold actions necessary to deal rapidly and effectively with the growing number of transnational challenges.

far worse. As predominantly rural societies have become more urban over the last 30 or 40 years, millions of migrants have been attracted to larger urban complexes without the resources or infrastructures to provide adequate healthcare, welfare, and education. The alternative social system provided by religious organizations has been a potent factor in winning mass support for religion. This holds across faiths.

The weaker the state and its mechanisms, the more critical the role of religious institutions and the stronger the appeal of religious ideologies, usually of a fundamentalist or theocratic nature.

A "Shadow" International System by 2025?
Further fragmenting the international system is the threat posed by growing transnational criminal networks in managing the world's resources—especially global energy, minerals, and other strategic markets—in addition to their traditional involvement in international narcotics trafficking. Increased demand for energy worldwide provides opportunities for criminals to expand their activities through direct ties to energy suppliers and leaders of countries where suppliers are located. With energy supplies increasingly concentrated in countries with poor governance, longstanding practices of corruption, and an absence of the rule of law, the potential for penetration by organized crime is high.

- The illicit activities of organized crime in the energy sector provide affiliated companies with an unfair competitive advantage in the global energy market.

- Over time, given their far-reaching tentacles into government offices and corporate board rooms, criminals may be in a position to control states and influence market actions, if not foreign policies. For many resource-rich countries, energy revenues provide the basis for the whole economy and energy policies are a key consideration in foreign policy decisions.

- The likelihood of penetration by criminal networks is probably greatest in Eurasian markets where organized crime has been an institutionalized part of the political and economic environment and where over time organized crime figures have evolved into influential businessmen and become valuable partners for corrupt officials.

- As Russian and Eurasian suppliers capture a larger and larger portion of the energy markets in Europe and Asia, we expect these organized crime networks to expand their operations, fostering greater corruption and manipulation of foreign policies to their advantage.

Global Scenario IV: Politics Is Not Always Local

In this fictionalized scenario, a new world emerges in which nation-states are not in charge of setting the international agenda. The dispersion of power and authority away from nation-states has fostered the growth of sub-national and transnational entities including social and political movements. Growing public concerns about environmental degradation and government inaction come together in this example to "empower" a network of political activists to wrest control of the issue out of country-level officials in capitals. Global communications technology enables individuals to affiliate directly with identity-driven groups and networks that transcend geographic boundaries. Environmentalism is an issue for which there is a widespread confluence of interests and desires.

Preconditions for this scenario include:

- National governments' relevance and power lessens in an increasingly decentralized world.
- Diasporas, labor unions, NGOs, ethnic groups, religious organizations, and others acquire significant power and establish formal and informal relationships with states.
- Communications technology permits ubiquitous and constant integration into identity networks.

FT.com
FINANCIAL TIMES

Politics is Not Always Local
September 14, 2024

We are in a new era in which governments are no longer king. All of us commentators talked a lot about the end of the Westphalian era, but we never really believed it. Moreover it was harder to get our arms around nonstate actors than to report on government ministries with their solid granite foundations and columned porticos. Now we have to recognize the new force of these loose networks. Unlike governments, they actually got something done. They have shown they really matter. I'm talking about the new climate change treaty that was recently agreed upon—even before the previous one expired—that instituted stricter carbon emissions ceilings and established global programs for renewable energy and new technologies to deal with the increasing water supply problems.

Of course, there is no single network and maybe that is the secret. Not only were there various national groups, but many of the networks responsible for forcing the climate change negotiations collected together professional groups, NGOs, and religious groups, across national, class, and cultural divides. The wide deployment of the next-generation Internet (Ubiquitous computing), although done for commercial reasons, greatly facilitated the empowerment of these nonstate interest groups.

This probably would not have come about without a succession of environmental disasters. The New York hurricane was a trigger. Importantly the fact that it happened about the time of UNGA, which many of these networks and groups had been scheduled to attend, facilitated the initial coalescence. However, it would not have happened without other events like the cyclone a year earlier that devastated Bangladesh and the recent Intergovernmental Panel on Climate Change report showing much higher levels of CO2 despite efforts at cutbacks. A crisis atmosphere prevailed. Indeed it was one of those moments in history in which a new millennium or apocalyptic atmosphere was operating—as if the end of the world was nigh—and immediate action was needed.

In a sense, we have reached the Promised Land in which global cooperation is more than a "conspiracy" among elites but bubbles up from the grassroots across historic national and cultural divides. We had hoped for this with the European Union but never achieved it. Everyone maintained his narrow parochial viewpoint, speaking first as a Frenchman, or Pole, not as a European.

A lot of this can be ascribed to the rise of the middle classes in Russia, China, and India. Like their Western counterparts before them in the 19th and 20th centuries, they are wealthy enough now to decry the health hazards associated with pollution and rapid growth. They wanted their governments to take action, but they did not. The middle classes have been incensed by the shoddy construction and poor planning that

led directly to large numbers of casualties when disasters struck. Anti-corruption and environmentalism merged. As the poor in Sub-Saharan Africa and elsewhere suffered more and more from climate change, religious activists also became mobilized. Migrants pushed off unproductive land, and unable to get access to clean water technologies, turned to churches for help.

Institutions were more savvy than governments in detecting the change. The annual Davos meeting was transformed several years ago. It brought in a host of activists from these networks and has since established virtual meetings where thousands more could participate. The pressure became too much for member-states to ignore. The UNGA set aside 20 seats for NGOs who yearly competed among themselves to take up a seat for a year and have the same voting rights as nation-states. International politics is forever changed even though I doubt these networks can be as effective on other issues. The environment was tailor-made because the widespread commonality of interest in avoiding Armageddon. At another time or on a different issue, my guess is national, religious, ethnic, and class differences will resurface. But the achievement stands and the precedent set will make it hard for governments to ignore NGOs. Maybe they can even begin to partner.

Chapter 7

Power-Sharing in a Multipolar World

The United States will have greater impact on how the international system evolves over the next 15-20 years than any other international actor, but it will have less power in a multipolar world than it has enjoyed for many decades. Owing to the relative decline of its economic, and to a lesser extent, military power, the US will no longer have the same flexibility in choosing among as many policy options. We believe that US interest and willingness to play a leadership role also may be more constrained as the economic, military, and opportunity costs of being the world's leader are reassessed by American voters. Economic and opportunity costs in particular may cause the US public to favor new tradeoffs.

Developments in the rest of the world, including internal developments in a number of key states—particularly China and Russia—are also likely to be crucial determinants of US policy. A world of relatively few conflicts with other major powers would smooth the way toward development of a multipolar system in which the US is "first" among equals. In the end, events will shape the parameters of US foreign policy. Contingencies—such as the use of nuclear weapons or WMD terrorism—could convulse the entire international system and refocus the US role.

Demand for US Leadership Likely to Remain Strong, Capacities will Shrink

Despite the rise in anti-Americanism over the past decade, the US is still likely to continue to be seen as a much-needed regional balancer in the Middle East and in Asia. A recent survey (see box on pages 95-96) indicates growing unease with China's rise among its neighbors and, in many regions, a leveling off of antagonism, if not some improvement in attitudes toward the United States. In addition to its increasing economic power, China's military modernization program is a growing source of concern to its neighbors. The level of concern may rise even if Asia's security improves, for example, with a PRC-Taiwan accommodation, though in such an eventuality the opposite reaction is also possible. In the Middle East, a nuclear Iran would increase pressure for extension of a US security umbrella to Israel and other states.

"Developments in the rest of the world…particularly [in] China and Russia—are also likely to be crucial determinants of US policy."

Other states will continue to seek US leadership on the newer "security" issues, such as climate change. For example, many countries view US leadership as critical to encouraging major developing countries like China and India that are emitters of greenhouse gasses to take on serious commitments to reduce carbon emissions in a post-2012 emissions control regime. Most G-77 countries realize they are absorbing environmental harm from polluters and are not averse to the US intervening with Beijing.

Further, others will seek US leadership on countering WMD proliferation by taking steps to dissuade interest in WMD, strengthening nonproliferation regimes, preventing acquisition of WMD and associated expertise and technology, rolling back or eliminating WMD in countries of concern, fostering deterrence in the use of WMD, and mitigating the consequences of WMD use.

New Relationships and Recalibrated Old Partnerships

An increasingly multipolar world suggests a greater number of actors—including influential nonstate ones—with whom the US and other powers will have to contend. Descent into a world in which mercantilism and resource nationalism become the overriding *modus operandi* for others

probably would narrow the number of US partners, increasing the risks of tensions, if not confrontation among the powers in such a zero-sum world. On the other hand, a world of continuing prosperity would enhance prospects for greater burden-sharing and steps towards revitalization of multilateralism and global institutions.

During the period out to 2025, China and India are likely to remain *status quo* powers focused on their own development, drawing benefits from the current system and not too eager for the US or others to seek radical changes to the international order until Beijing and New Delhi judge that they are in a better position to help set the new rules of the road.

Although the emerging powers will want to preserve ample leeway and autonomy to exert regional influence independent of the United States, their relationships with the US are likely to deepen if their plans for greater economic development remain on track. Economic collapse, especially in China's case, could lead to a nationalistic upsurge and increased tensions with foreign powers, including the United States.

Europe will face difficult domestic challenges that *could* constrain its ability to play a larger global role, especially in the security realm. A sense of increased threat—whether from terrorism or a resurgent Russia—could change the European calculus on the need for more defense spending and greater capacity for unified action. Growing interest in Maghreb and Middle East economic and social developments increases the potential for Europe to play a stabilizing role similar to what it accomplished with enlargement to the East. Japan, to keep pace with China, may increase its political and security role in the region. We expect other countries, such as Brazil, to assume more expansive regional roles and to increase their involvement on certain key global issues such as trade and climate change.

Current trends suggest Russia has a more immediate interest in directly challenging what it sees as a US-dominated international system than do other rising powers. A more diversified economy, development of an independent middle class, and reliance on foreign technological expertise and investment for development of its energy resources could change that trajectory, however. An earlier-than-anticipated move away from fossil fuels also could undercut Russia's recent resurgence.

In the Middle East, where the US is likely to remain the dominant external actor, current trends suggest a greater role for Asian states which are reinforcing their growing economic links with stronger political ties. Asian powers—in addition to European ones—could seek or be drawn into roles in any future international security effort in the Middle East. The role of NGOs will grow commensurate with the increase of humanitarian needs owing to climate change. In turn, the international community, including the US, will become more dependent on NGOs to shoulder the burden of humanitarian relief.

Less Financial Margin of Error

The dollar is vulnerable to a major financial crisis and the dollar's international role is likely to decline from that of the unparalleled "global reserve currency," to something of a first among equals in a basket of currencies by 2025. This could occur suddenly in the wake of a crisis, or gradually with global rebalancing. This decline will entail real tradeoffs and force new, difficult choices in the conduct of American foreign policy.

Anti-Americanism on the Wane?

America's reputation abroad has fluctuated over the decades—from the *Ugly American* of the 1950s to the widespread international protests over Vietnam in the 1960s and 1970s to anti-nuclear activism in Europe in the 1980s. Anti-Americanism has experienced an upsurge during this decade. Between 2002 and 2007, the US image became less favorable in 27 of 33 countries polled. Attitudes critical of the United States can be parsed into two basic categories:

- "Transitory criticism" fueled by disagreements with specific aspects of the United States that can change with time, such as its foreign policies.

- "Anti-Americanism" reflecting deep and undifferentiated antipathy toward most aspects of the United States.

To the extent that certain aspects of American life—for example, its political system, people, culture, S&T, education, and business practices—are seen abroad as admirable, perceptions of the United States will be complex, keeping views flexible and open to revision. The downward trajectory of America's reputation suggested above may have bottomed out. Polling in 2008 by Pew's Global Attitudes Project found US favorability ratings up in 10 of the 21 countries for which trend data are available. Looking ahead, what regional drivers and dynamics might be pivotal for encouraging such a turnaround?

Europe/Eurasia. In contrast to regions more uniformly pro- or anti-American, Europe/Eurasia tends to hold more volatile views of the US. The views of Western Europeans appear to be buoyed to the extent that the United States, its key allies, NATO, and the EU deepen practical multilateral approaches to international problems. The views of Central and East Europeans, who are traditionally favorable toward the United States, probably will recede over time to the West European norm. No single set of US actions will reassure all states of the former Soviet Union, but avoiding a heavy movement of military assets into Moscow's perceived Near Abroad would stave off the tensest of relations with Russia.

Near East/South Asia. Societies most hostile to the United States are found in the Islamic Middle East, as well as Pakistan and North Africa. India is an important exception. Drivers for turning around the US image include a strong commitment to significant progress on Israel/Palestine, disentangling anti-terrorism from a perceived war on Islam, and seeking to provide aid to needy citizens in addition to military-security elites. To the extent Iran is perceived to be a dangerous revisionist power, people and states in the region will tend to view US military capability positively.

Sub-Saharan Africa. Africa continues to harbor goodwill toward the United States. Publics in Sub-Saharan Africa tend to find American lifestyles and standards of living enviable. If AFRICOM, the new US military command, does not present an overly militarized face to citizens in African countries, and humanitarian and economic developmental aid continues, the surveys suggest African opinion about the United States will remain favorable.

(Continued on next page…)

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East/Southeast Asia: Views of the United States in this region are relatively positive. Despite China's economic growth, and nascent Asian integration, US "soft power" still eclipses China's. The United States will continue to be looked to as a reliable security partner in Northeast Asia, and to a lesser extent in Southeast Asia. Public perceptions are at risk of downward swings in China, depending on portrayals of the United States in the country's official media.

Latin America: On balance, views of the United States are fairly favorable and stable, much more so in Central America, but less so in the Andean region. Some level of migration to the United States for jobs and subsequent remittance of earnings back to Latin America will be a key. Also important will be the degree to which US and Latin interests are viewed as shared, especially on multilateral tasks such as interdicting illegal drug supplies and combating organized crime and gangs.

Aggregating across regions, what does the tally sheet of factors affecting anti-Americanism look like out to 2025? First, factors favorable to the United States:

- Many state leaders and publics are distrustful of vast ***power*** itself, independent of the owner. As China becomes more powerful, some wariness will be displaced onto Beijing, and the United States' own function as a counterweight will become more appreciated.

- The US is benefiting from a likely turn in the ***battle of ideas***. First, and foremost, support for terrorism has declined dramatically over the last few years in many Muslim countries. Fewer Muslims now consider suicide bombing justifiable, and confidence in Usama Bin Ladin has waned.

- As big emerging markets in Asia and elsewhere grow, ***globalization*** will less often be equated with *Americanization*. As traditional ways of life are upset around the globe, unwanted foreign ideas and customs will appear more the product of modernity than of American sprawl.

Potentially unfavorable would be perceived slowness in tackling pressing transnational problems such as global climate change, food security, and energy security. A currently indeterminate factor will be the effect of increasingly pervasive mobile telephony, Internet connectivity, and direct satellite media on how individuals around the world receive their images of the United States. On balance, however, major trends suggest that anti-Americanism is declining.

- The dollar's global reserve status confers privileges on the US including insulation from risk of currency shocks, which enables lower interest rates, while a steady source of outside demand for US dollars affords the US a unique ability to run large fiscal account deficits without reproach from the global economy.

Enjoyed by the US for more than 60 years, these privileges have perhaps so permeated US thinking as to go unnoticed. While total loss of reserve status is unlikely, the dollar's decline may force the US into difficult tradeoffs between achieving ambitious foreign policy goals and the high domestic costs of supporting those objectives. In the face of higher interest rates, higher taxes, and potential oil shocks, the US public would have to weigh the economic consequences of taking strong military action, for example. The impact on others desirous of a stronger US role could be equally great if the US would decline or be unwilling to take action. In addition, US financial dependence on external powers for fiscal stability may curtail US freedom of action in unanticipated ways.

More Limited Military Superiority

In 2025, the US will still retain unique military capabilities, especially its ability to project military power globally, that other nations will continue to envy and rely on to secure a safer world. The United States' ability to protect the "global commons" and ensure the free flow of energy could gain greater prominence as concerns over energy security grow. The US also will continue to be viewed as the security partner of choice by many states confronted with the rise of potential hostile nuclear powers. Although the emergence of new nuclear-weapon states may constrain US freedom of action, US military superiority in both conventional and nuclear weapons and missile defense capabilities will be a critical element in deterring openly aggressive behavior on the part of any new nuclear states. The US will also be expected to play a significant role in using its military power to counter global terrorism.

"Anticipated developments in the security environment leading to 2025 may raise questions about traditional US advantages in conventional military power."

However, potential US adversaries will continue to try to level the playing field by pursuing asymmetrical strategies designed to exploit perceived US military and political vulnerabilities. In the future, advanced states might engage in counterspace strikes, network attacks, and information warfare to disrupt US military operations on the eve of a conflict. Cyber and sabotage attacks on critical US economic, energy, and transportation infrastructures might be viewed by some adversaries as a way to circumvent US strengths on the battlefield and attack directly US interests at home. In addition, the continued proliferation of long-range missile systems, anti-access capabilities, and nuclear weapons and other forms of WMD might be perceived by potential adversaries and US allies alike as increasingly constraining US freedom of action in time of crisis despite US conventional military superiority.

- Traditional US allies, particularly Israel and Japan, could come to feel less secure in 2025 than they do today as a result of emerging unfavorable demographic trends within their respective countries, resource scarcities, and more intensive military competitions in the Middle East and East Asia, especially if there is also doubt about the vitality of US security guarantees.

Surprises and Unintended Consequences

As we have made clear throughout this volume, the next 15-20 years contain more contingencies than certainties. All actors—not just the United States—will be affected by unforeseen "shocks." For various reasons the US appears better able than most to absorb those shocks, but US fortunes also ride on the strength and resiliency of the entire international system, which we judge to be more fragile and less prepared for the implications of obvious trends like energy security, climate change, and increased conflict, let alone surprises.

While, by their nature, surprises are not easily anticipated, we have tried through the scenarios to lay out possible alternative futures and each is suggestive of possible changes in the US role.

A World Without the West. In this scenario the US withdraws and its role is diminished. In dealing with unstable parts of the world in its neighborhood like Afghanistan, China, and India, the Central Asians must form or bolster other partnerships—in this case the Shanghai Cooperation Organization. The fragmentation and breakdown of the global order into regional and other blocs—while not on the scale of US-Soviet bipolar split—probably would usher in an era of slower economic growth and globalization, less effective action on transnational issues like climate change and energy security, and the potential for increased political instability.

October Surprise. The lack of effective management of the tradeoffs among globalization, economic growth, and environmental damage is shared widely among more players than the US. Implicit in the scenario is the need for better US leadership and stronger multilateral institutions if the world is to avoid even more devastating crises. The results of miscalculation on the part of others—such as the Chinese—have significant political costs, which probably would make it more difficult for the US and others to put together a plan for more sustainable economic development, including conflicts among the major powers.

BRICs' Bust-Up. In this scenario, growing great power rivalries and increasing energy insecurity lead to a military confrontation between India and China. The US is perceived by Beijing as favoring India to China's detriment. Great power war is averted, but the protagonists must rely on a third party—in this case Brazil—to help reconstitute the international fabric. Given the BRICs' disarray, the United States' power is greatly enhanced, but the international system is in for a bumpy ride as the military clash leads to internal upheavals increasing nationalist fervor.

Politics Is Not Always Local. On some issues, such as the environment, a seismic shift in government versus nonstate actor authorities has occurred. For the first time, a coalition of nonstate actors is seen by a large number of electorates as better representing "planetary" interests and, in this scenario, governments must heed their advice or face serious political costs. This may not always be the case since on other more traditional national security issues, national, ethnic, class and other differences are likely to re-emerge, undercutting the clout of transnational political movements. The US, like other governments, must adapt to the changing political landscape.

Leadership Will Be Key

As we indicated at the beginning of the study, human actions are likely to be the crucial determinant of the outcomes. Historically, as we have pointed out, leaders and their ideas—positive and negative—were among the

biggest game-changers during the last century. Individually and collectively over the next 15-20 years, leaders are likely to be crucial to how developments turn out, particularly in terms of ensuring a more positive outcome. As we have emphasized, today's trends appear to be heading toward a potentially more fragmented and conflicted world over the next 15-20 years, but bad outcomes are not inevitable. International leadership and cooperation will be necessary to solve the global challenges and to understand the complexities surrounding them. This study is meant as an aid in that process: by laying out some of the alternative possibilities we hope to help policymakers steer us toward positive solutions.

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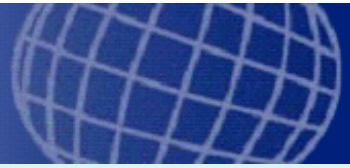

Toward a U.S. Export Control and Technology Transfer System for the 21st Century

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Background and Environment

National Challenges

- The United States is currently involved in a **wide spectrum of complex national security challenges** around the world. Challenges posed by rising regional powers, global terrorism, and failed states will be long and enduring. These can only be effectively met with the help of our allies and coalition partners.
- Unlike the distinct and isolated blocs of the Cold War, we now exist in a **globalizing world** where information, people, and goods move across national borders with greater speed and ease than at any time in modern history
- A professionalized, well-trained and technologically superior military has been the key to U.S. national security for over fifty years. The **ability to access the world's best technology and use them for the benefit of the U.S. military has been a key** component of this strategy. Maintaining this technology edge has never been more difficult than it is now.
- Similar to President Eisenhower's profound insight that the long struggle with the Soviet Union would require a strong economy as much as a strong military, the **current set of national security problems can only be engaged over the long term with a healthy economy and industrial base**.
- **The regulation of defense exports sits at the intersection of all of these issues**

The Export Control Environment

- The U.S. Export Control system is **under increasing strain** due to the changing nature of the defense export environment
  - High tempo of coalition allied operations in Iraq and Afghanistan **increasing the volume of licenses**
  - Rising scale and scope of current international defense development programs (Joint Strike Fighter, Missile Defense, International Space Station, etc) **increasing the complexity of licenses**
  - **Globalization** of corporate ownership and industry supply chains
  - Increasing use of **commercial technology** for military and dual-use purposes
  - Accelerating pace and geographical **diffusion of technological innovation**
  - Migration of R&D centers to where **collaboration is easiest versus "safest"**

- Evidence of **systemic stress** can be seen in the growing caseload levels for U.S. State and Commerce Department regulators since 2001
  - 50% increase in annual munitions export license applications
  - Doubling of annual demand for dual-use licenses
  - Technical Assistance Agreements and Foreign Manufacturing Licenses now have a total value roughly equal to that of all hardware licenses
  - Annual licensing officer caseloads are up 53% for State and 63% for Commerce

The Export Control Environment (Cont'd)

- The **pace of military operations, international cooperation, and business are accelerating as time becomes a strategic differentiator** - often to a pace that Export Control timelines cannot currently accommodate
  - License processing times at State, Commerce and Defense have shown steady improvement over the past decade but still disconnected from accelerating required response rates
- **Complexities of foreign assistance policies** increase as military systems sometimes outlast allied governments and/or U.S. policies
- **The value of intelligence** and intelligence-sharing continues to increase significantly in this environment as potential adversaries and their support networks diffuse

Another Indicator of Strain Is the Number of Reform Efforts Under Way By A Range of Stakeholders

US Government

- Deemed Export Advisory Committee (Commerce)
- Internal State Department Review (State)
- IPT-DTSA / International Cooperation (Defense)
- Congressional Export Control Working Group (Congress)

Allies

- Defense MOU Attaches Group Exports Project
- Security Defense Agenda in Brussels

Industry

- Coalition for Security and Competitiveness
- AIA
- NATO Industrial Advisory Group

Think Tanks

- Atlantic Council of the United States Export Controls workshops
- CSIS
  - Export Control for the 21st Century
  - US Space Industry Health/Export Control Impacts
  - US-UK Technology Sharing Workshops
- Heritage Foundation Workshops
- Hudson Institute "Obstacles into Opportunities"
- Science, Security and Prosperity in a Changing World (NAS)
- Export Controls and the US Industrial Base (IDA)
- Science and Security in a Post 9/11 World (NAS)
- Rising Above the Gathering Storm (NAS)

Recent Outputs

- US-UK and US-Australia Defense Cooperation Treaties
- White House Directive on U.S. Export Control Reform

The Philosophical Debate Under Way

- Virtually all current reform efforts start with the premise that this is a national security issue – versus primarily an economic problem
- However there are two major philosophical camps (often speaking past each other)
  - **The "It's the Resources and Processes" Camp**
    - Generally believe the structure of the underlying laws and statutes are robust and flexible enough to achieve the intended strategic goals
    - The key issue is adequately resourcing licensing and enforcement
    - Furthermore, particular attention should be focused on management and efficiency reforms
    - If licensing times dropped, complaints would stop
    - The current system is time-tested but needs to be more user-responsive
  - **The Structural Reform Camp**
    - Believe the system will never receive the sufficient resources required nor will adequate business processes be implemented
    - Therefore a fundamental redesign is required, want to rewrite AECA and EAA statutes
    - Focus on:
      - Reducing the volume of licenses by "triage" – create decision models that generate default answers, focus on the exceptions
      - 'Higher barriers around fewer things' approach

Findings of Concurrent Studies

Current Reform/Study Efforts	Common Themes in Findings: International Cooperation Limited/ Difficult	Exist Controls Limit Innovation	System Not Adapted to Globalization	Existing Controls Hurt U.S. Competitive	Licensing Process Under Strain	Laws/Regs Misunderstood by Users
Commerce Deemed Exports		Strong	Strong	Strong		Partial
Defense IPT-DTSA	Strong					Partial
GAO	Partial		Partial		Strong	Strong
Defense MOU Attaches Group	Strong				Partial	
Security and Defense Agenda	Strong		Strong	Strong	Partial	
US-UK and US-Australia Treaties	Strong					
White House Exp. Cont. Direct			Partial	Partial	Partial	
Congress - Def. Trade Imp. Act	Partial	Partial		Partial	Strong	Partial
Coal. for Security and Compet.	Partial		Partial	Partial	Partial	
CSIS Treaty and Space Reports	Strong	Strong	Strong	Strong	Partial	
Hudson Report	Strong	Strong	Partial	Partial	Partial	
IDA Report	Partial	Strong	Partial	Partial	Partial	Partial
NAS Reports		Strong	Partial	Partial		

Legend Strong Findings; Partial Findings; Weak/No Findings

Recommendations of Concurrent Studies

Current Reform/Study Efforts	Common Recommendation Themes: Increase Licenseing Efficiency/ Transparency	Clean-Up Control Lists	Improve Interagency Coordination	Improve Exporter Interface	Limit Scope of Tech Controls	Strength International Agreements	Apply Sub-National Focus
Commerce Deemed Exports							
Defense IPT-DTSA							
GAO							
Defense MOU Attaches Group							
Security and Defense Agenda							
US-UK and US-Australia Treaties							
White House Exp. Cont. Direct.							
Congress - Def. Trade Imp. Act							
Coal. for Security and Compet.							
CSIS Treaty and Space Reports							
Hudson Report							
IDA Report							
NAS Reports							

Legend Strong Recommend | Partial Recommend | Weak/No Recommend

Problem Summary

- The U.S. export control system, as currently structured, is unable to respond as fast as the evolving security environment is changing, resulting in severe strains on the system itself and on its stakeholders
- The friction caused by the system is unintentionally impacting the broader national security goal of maintaining U.S. technology edge
- Globalization and commercialization have reduced the U.S. government's ability to control many defense-relevant technologies
- The current export control licensing process, though continuously improved, still does not meet the pace of international allied operations or business timetables

Key Findings of CSIS Process and Recommendations

1) *Who* is becoming more important than *what*

- Many of the export control reform efforts over the past 20 years have focused on the "what should be controlled" as basis for reform
  - Incessant calls for reviews of the export control lists
  - The basis of the "the higher walls around fewer things" argument
  - Made sense when the "who" was well defined – Soviets and the Warsaw Pact
- However, in the current environment the "who" question is becoming the primary one:
  - As ad-hoc coalitions are created to address particular national security issues, changing the calculus of "what" is shared
  - As economic relationships deepen with potential political adversaries
  - As the realities of globalization blur the distinction of national identity (what is an American company? One based in the US? Owned by Americans? Headquartered in America?), forcing analysis to go below the national level
- The "what" question is ultimately often answered by asking "for whom?"

1) *Who* is becoming more important than *what* (cont.)

- Some of the major initiatives that have been recently launched are grounded in the question of "who"
  - The Validated End-User program is based on verifying "who", and determining whether they are a trusted entity
  - The US-UK and US-Australia Defense Trade Cooperation Treaties is also focused on "who"
    - Established notion of "trusted communities"
    - Not national exemptions but is explicit about lower walls around "trusted entities"
  - Expedited processes for coalition partners in Iraq and Afghanistan
- A shift in emphasis to "who" places a greater burden on the front end of the process (intelligence) and on the back end (enforcement)

1) *Who* is becoming more important than *what* (cont.)

- **Recommendations:**
  - **Identify areas for expansion of the "trusted community" idea,** communities where waivers from licensing of particular items can be established or one time master licenses can be established (the UK and Australian "trusted communities" represent the high end of the spectrum)
    - International cooperative programs
    - Coalition partners
    - Training & exercises partners
    - Treaty allies
    - Verified end user programs
  - Establish threshold levels for membership in the "trusted community" and identify "what" will be exempt from licensing (but may require notification)
    - Example: Spares and consumables for training & exercise partners
    - Example: Permit the license-free transfer of common equipment between treaty allies (NATO operators of F-16s or Apache helicopters), license required if transferred outside "trusted treaty community"

2) Focus on *how* to undertake Control List reviews

- Common theme amongst the export control reform studies is frustration with the control lists
  - Deemed to be out of date
  - Slow to capture new, emerging technologies
  - Slow to reflect changing landscape in terms of global availability and state-of-the-art
- List reviews are time and resource consuming and not the primary responsibility of any one entity
  - Deep technical expertise exists within USG, however that expertise is being tapped for multiple purposes
- Given that it is accepted wisdom that the control lists need review and updating, the focus of reform efforts should be on *how* to achieve this goal

2) Focus on *how* to undertake Control List reviews (cont.)

- **Recommendations**
  - **Establish a National Technology Assessment Group that can be a shared resource for the USG**
- Supports existing USG resources within Department of Defense, State and Commerce
- Serves as an un-biased USG source for data about new and evolving technology developments, particularly important with the convergence of defense, commercial and international technology
- A technical, not a policy, resource
- Housed within a neutral body such as National Academies or other suitable USG-affiliated entity
- Would pull from Academia and Industry as well as USG - limited, highly-qualified staffs
  - **A National Technical Assessment Group could be a resource for other communities – industrial policy, intelligence, etc. - with similar needs**

3) Reduce friction in the system through *cohabitation*

- The focus of many export control reform studies currently under way is on the symptoms:
  - Timeliness
  - Apparent lack of transparency
  - Apparent lack of consistency
  - Jurisdictional battles
- There are three legitimate points of view – national security, foreign policy and economic security. The presence of three key actors – Defense, State and Commerce – is required to represent the multiple points of view. The side effect of the multiple points of view and the presence of two governing laws (Arms Export Control Act and the Export Administration Act) is the "friction" in the system
  - Some of the reform efforts call for the creation of single entity/agency in order to reduce the friction, however this destroys the benefit of the multiple points of view
- Goal should be to derive the benefits of the multiple points of view while minimizing the friction of the system

3) Reduce friction in the system through *cohabitation* (cont.)

- **Recommendations:**
  - **"Cohabitate" the primary export licensing functions of State, Commerce and Defense**
    - Leverage a best business practice – integrated teams
    - Leave policy functions at existing parent departments and leave "ownership" of resources/people with existing parent departments (NOT an argument for single agency)
    - "Cohabitation" can be virtual
      - Leverage 21st century technology - robust datalinks ("fat pipes"), common IT systems, desktop video teleconferencing, etc.
      - Or, if virtual does not generate desired effect, then physical cohabitation
  - Interdepartmental coordination should be significantly enhanced by cohabitation and the resulting more frequent interaction among staffs and managers. Friction should be reduced through greater understanding at the licensing officer/staff levels of other departmental concerns and capabilities

4) A new international export control regulatory regime is required to adapt to the globalized and commercialized technology and industrial base

- Ultimately, any export control regime will have to have a functioning international component in order to be successful.
  - Strong US controls alone cannot keep dangerous technologies away from adversaries
- It will require US leadership and have the support of the major exporting nations of the world
- A key component of the "trusted community" concept is a strong set of national laws that can establish who is within the trusted community and sufficiently punish violators
- **Recommendations:**
  - **Develop bilateral and regional export control regimes to enable "trusted community" structures**
  - **Initiate process to strengthen and update multilateral regimes (Wassenar)**

Appendix

Appendix A: Study Approach

- Review of relevant literature and past USG initiatives
- Interviews with 102 individuals representing key stakeholder groups
- Quantitative data analysis
- Analysis of findings and synthesis of key themes
- Compare parallel efforts at reform
- Convening four rounds of working group sessions to vet and socialize findings and proposed recommendations
- Roll-out report in concluding conference

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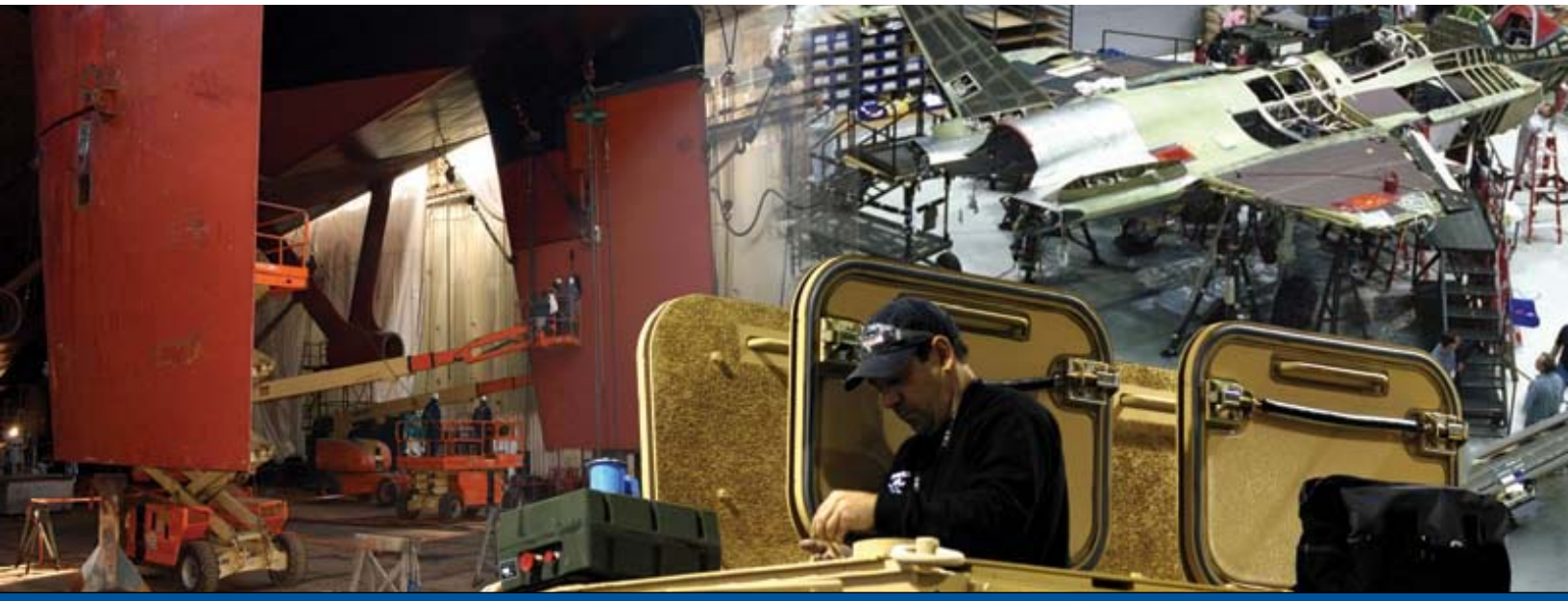

STRATEGY FOR THE LONG HAUL

CSBA

The US Defense Industrial Base

Past, Present and Future

BY BARRY D. WATTS

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THE US DEFENSE INDUSTRIAL BASE: PAST, PRESENT AND FUTURE

STRATEGY FOR THE LONG HAUL

By Barry D. Watts

2008

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EXECUTIVE SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

1) What kind of defense industry is in the best interest of the United States, today and in the future?

2) If the defense industry best suited to cope with the challenges of the decades ahead is substantially different from what it is today, what steps might be taken to begin bringing about the required transformation?

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

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

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

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

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

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

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

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

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

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

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

6 Ibid., p. 2.

The reader should be aware that this report uses a broader notion of "acquisition" than that found in the "how to buy" policies and practices detailed in Department of Defense (DoD) Directive 5000.1, *The Defense Acquisition System*, and DoD Instruction 5000.2, *Operation of the Defense Acquisition System*, as revised in 2003. Expanding on the narrow view of defense acquisition in these documents, the report construes the notion of US government's "buying practices" to include additionally the Joint Capabilities Integration and Development System (JCIDS) instituted to improve DoD's requirements process[7]; the DoD planning, programming and budgeting system (PPBS) used to execute defense programs; the decisions made by the White House and Congress regarding defense programs; and the informal activities that have evolved among these various participants in defense acquisition, including bargaining, gamesmanship, and tacit alliances among various stakeholders and participants.[8]

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

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

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

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

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

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

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

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

[11] See GAO, "Defense Acquisitions: Assessments of Selected Weapon Programs," GAO-08-467SP, March 2008.

CHAPTER 1 > **FUTURE FUNDING LEVELS FOR DEFENSE**

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

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

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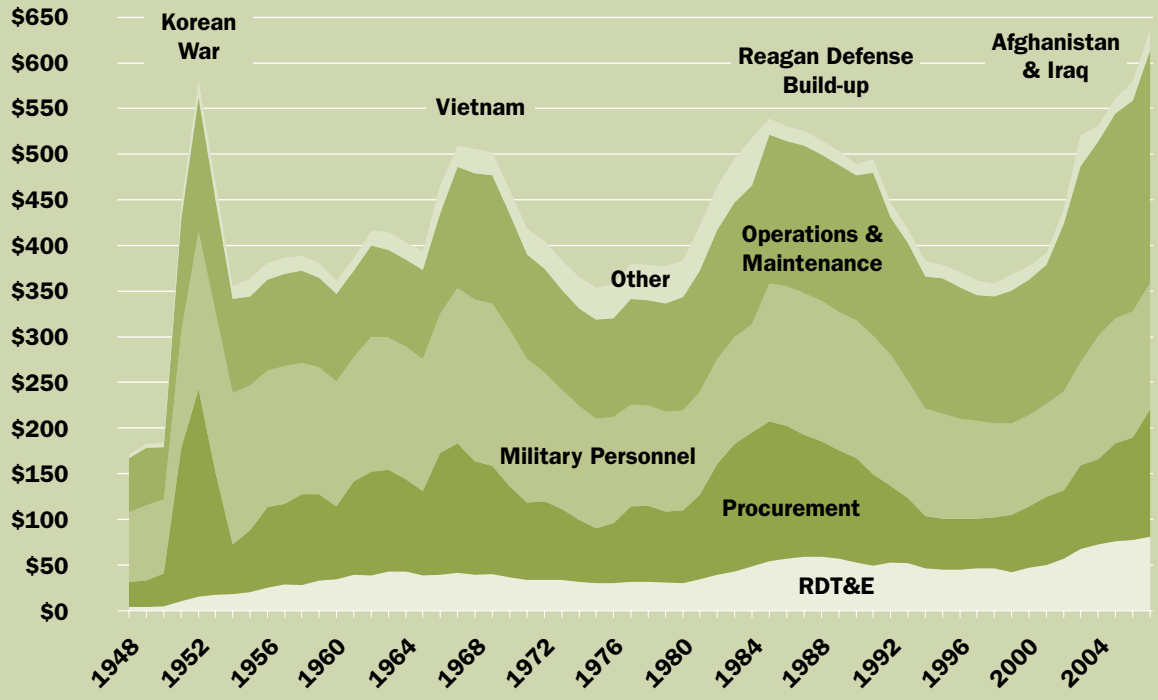
[12] In contrast to many industries, the customer (the US government) publishes its overall spending plans for at least five years into the future on an annual basis. These government budget documents also go into great detail to describe individual programs and their expenditures and even the companies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

departure, Figure 1 displays DoD total obligational authority (TOA) for both RDT&E and procurement from fiscal year (FY) 1948 through FY 2007.[13] The expenditures are in constant FY 2009 dollars, which means that the effects of inflation over time have been eliminated. From 1948 to 2007, DoD's annual RDT&E investments show a gradual long-term increase, but do not exhibit the volatility of procurement from one year or period to the next. Note, too, the increases in procurement associated with the Korean and Vietnam Wars, as well as with the later increases associated with the build-up in defense spending during the first term of President Ronald Reagan's administration. Starting in 2001, DoD TOA also begins including supplemental

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

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



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

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

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

- From an industrial base perspective, the defense business is a cyclical market. Peaks in DoD spending are tied to major events such as wars or the Reagan administration's efforts to use defense spending to put pressure on the Soviet Union during the final decade of the Cold War,. In the wake of these events, defense spending declines. The cycles are measured in decades. Debates are now ongoing about whether there will be a post-Iraq decline. The answer to that question will influence how firms in the industry view the future business opportunities in national defense, affecting their decisions about whether to remain in this market.

- The surges appear to be mainly in procurement, although over time there has been steady, long-term growth in military personnel and operating costs. Today's all-volunteer force is more expensive to pay and operate than the military establishment was when personnel could be drafted. These costs have consumed an increasing percentage of the DoD budget and put more downward pressure on procurement. Consequently, manufacturing—historically the key source of revenue and profitability for companies—has been subject to significant swings in demand and has been under increasing pressure even in the periods between peaks in DoD TOA. This affects the attractiveness of the industry to companies.

- On an annual basis, R&D funding has shown long-term growth since the late 1940s. It has also not been cut significantly even in the troughs between periods of peak defense spending. Over the period 1948–2007, total RDT&E funding has been about 42 percent of DoD's cumulative procurement spending. At the broadest level these observations suggest that the government has become increasingly inclined over time to invest in technology but not always willing to move new military technology into significant production of new equipment.

- Finally, the pattern of the defense industry over the past half century—and particularly during the past two decades—has been one of fewer and fewer competitors

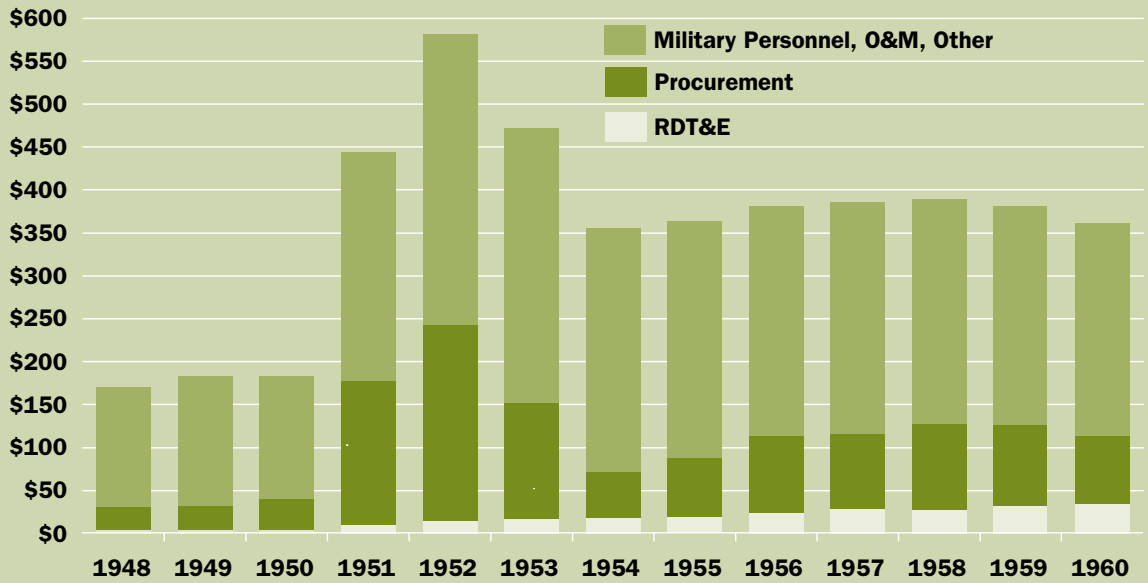
[14] CBO, "Analysis of the Growth in Funding for Operations in Iraq, Afghanistan, and Elsewhere in the War on Terrorism," February 11, 2008, p. 3.

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

THE "GROWTH" PERIOD: 1945–1960

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

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



Louis Johnson, were unenthusiastic about the hefty increases in military spending implicit in NSC-68.[15] Once war broke out on the Korean Peninsula, however, an ad hoc NSC committee drafted NSC-68/1, which envisioned US defense spending growing from $35.3 billion in 1951 to $63.4 billion by 1953.[16] As a result, DoD's budget authority quickly swelled to a peak of $60.2 billion in FY 1952 ($604.2 billion in FY 2009 constant dollars).[17]

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

As Figure 2 indicates, even ignoring the spike in defense spending associated with the Korean War, from 1948 to 1960 the US defense budget grew substantially. The growth rate over this period averaged between 6.4 and 6.5% per year, depending on whether one uses TOA (the direct value of the defense program in a given fiscal year) or budget authority (the ability to obligate funds either immediately or in the future).[20] Using budget authority (BA), the 051 appropriations account went from $171.4 billion (in FY 2009 constant dollars) to $361.3 billion. Looking at subsequent time spans of about a decade, the next period in which DoD's average annual TOA growth rate matched that of the 1948–1960 period is 1998–2007.

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

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

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

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

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

[20] Comparison of 051 BA and TOA over the 1948–2007 period shows only minor, occasional differences between these two measures of defense spending. The larger differences are between TOA or BA and outlays.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[28] Ibid., pp.168, 211

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

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

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

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

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

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

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

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[31] Ibid., p. 107.

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

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

> EMPHASIS ON ADVANCED TECHNOLOGY: By the late 1950s, the American defense industry had already demonstrated its heavy emphasis on research and development. Studies showed that it spent or consumed more R&D investment dollars per sales dollar than non-defense industries. For example, in 1956 the R&D expenditures for aircraft and aircraft parts were about 19 percent of sales while the percentage for American industry overall was less than 3 percent. Military R&D also often led, rather than lagged, the commercial sector in the application of technology to products. While defense R&D often focused on new hardware and systems, in commercial firms the majority of R&D was for product improvements.[34]

> REQUIREMENTS FOR INDUSTRY TO MAINTAIN HIGH LEVELS OF ENGINEERING SKILLS AND CAPABILITIES: In the 1950s the high demands for engineering skills already distinguished the US defense industry. Defense firms recognized that both individual and team skills were needed to effectively develop complex defense systems. That in turn required time and sustained effort. Companies consequently were reluctant to reduce their engineering force when projects were cancelled because of the time required to rehire personnel and rebuild critical skills. Also, shortages of engineers were already a long-term problem and remained so in later decades.[35]

> DIFFICULTIES IN MEETING GOALS FOR COST, SCHEDULE AND PERFORMANCE: Studies showed that firms often fell short of the initial goals for developing complex defense systems. For example, a study of twelve major programs during the period 1945–1960 showed that, on average, actual cost was 3.2 times predicted cost, and average development time was 1.36 times that originally predicted. By rough measures (e.g., speed, range or payload), performance also varied from initial goals by factors of 0.8 to 2.0. One 1957 report concluded that the lead time for full introduction of an advanced manned aircraft was eleven years.[36]

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

[34] Ibid., p. 25. See also pp. 9, 45.

[35] Ibid., pp. 170–182.

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

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

> DIFFERENT CAPITAL REQUIREMENTS AND POTENTIAL PROFITS: Because of the costs of large systems and the government's capacity to change its buying commitments, firms could not, in most cases, privately finance the development and production of weapon systems.[37] The government thus used progress payments to relieve firms of the burdens of financing new technology efforts.[38] However, companies could not control their profit levels as well as private-sector firms because the price of a weapon system was not set by market competition but, instead, was largely determined by reimbursement of costs.[39]

> THE GOVERNMENT'S POWER AS A MONOPSONY BUYER: The government was the only major buyer, which meant that, unlike most commercial market situations, the government could virtually dictate the characteristics, number and delivery of products or services. The government could decide whether a new weapon was needed, thereby giving it control over new product development, the seller could not offer a finished product which the buyer could either accept or reject, and the government could (and frequently did) change, reduce or cancel a project before its completion.[40]

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

THE "MATURE" PERIOD: 1961–1990

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

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

38 Ibid., pp. 214–215.

39 Ibid., pp. 53, 56–57.

40 Ibid.

41 Ibid., pp. 220.

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

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

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

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

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

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

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

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

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

- GROWING GOVERNMENT EXPENDITURES FOR NON-DEFENSE ACTIVITIES: The great increase in non-defense spending in the 1960s that resulted from various domestic initiatives changed the political and budgetary dominance of defense spending within the US government. First, this change created alternative demands for government funds. Second, it created a host of government agencies and interest groups that competed against DoD and the defense industry for the federal government's spending. Third, in the 1980s, when huge deficits created demands to cut government spending, the defense budget was a more readily accessible target for reductions than many domestic programs.[47]

- THE INCREASING SOPHISTICATION OF MANAGEMENT: Throughout the last half of the twentieth century, research into how and why businesses succeed or fail grew among universities, consulting firms, think tanks, and business firms themselves.[48] This focus on management was caused by a number of factors. One, of course, was the growth of business education. Today the MBA (master of business administration), which originated in the United States, is the second or third most awarded master's degree. Other factors were the success of Japanese firms like Sony and Toyota in various markets, and the emergence of increasingly competitive markets in the United States and around the world. The results were a myriad of ideas,

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

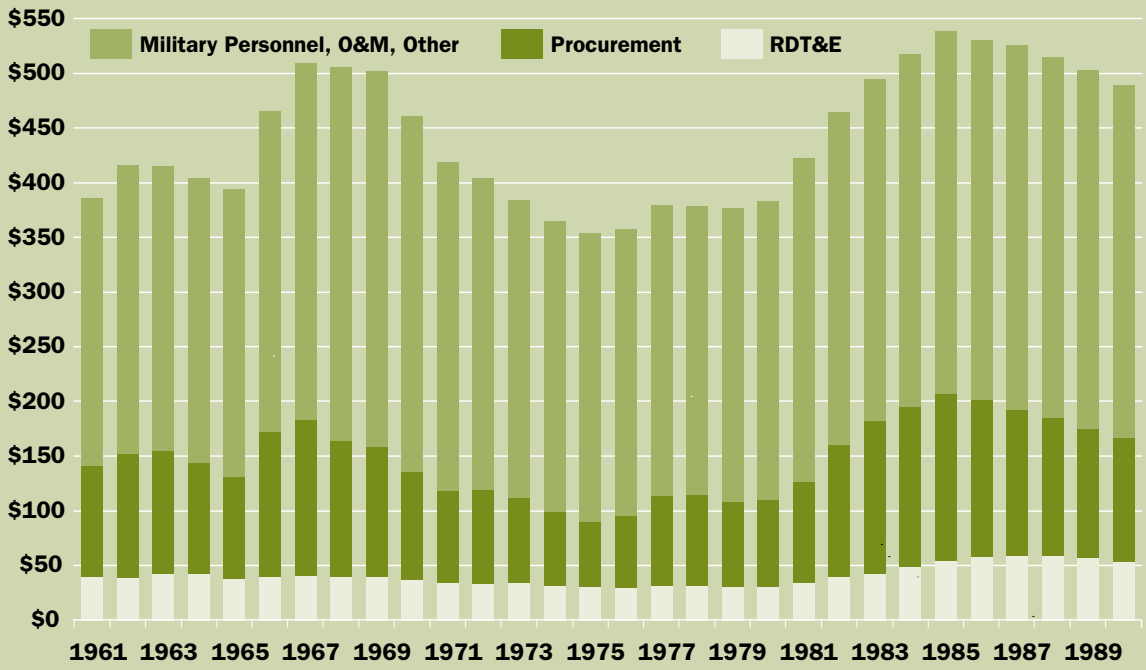
47 The US national debt reached $400 billion in 1980. By 1988, only eight years later, it was $3.2 trillion, an eightfold increase. In the mid-1980s the government began passing a series of laws to reduce deficits that were $200–300 billion annually (and would have been higher if the government included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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

> Investors believe that defense industries operate in a highly unstable and excessively complex business environment characterized by high risk, restricted cash flow, and low returns.
>
> Investors' skepticism has caused a virtual closure of the equity and debt markets to all but a few major contractors.
>
> Companies struggle to raise their profitability in the short-term at a time when price-earning ratios in many defense sectors are the lowest in at least 25 years.[58]

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[56] From 1984 to1987, DoD policy changes included limiting companies' ownership of data rights, changing cost sharing rules, reducing profit percentages, lowering progress payments, requiring companies to invest in special tooling, changing thresholds for unallowable costs, and altering when taxes had to be paid. The collective impact of these changes would have cut 1985 profits of a sample of firms by 23 percent, and for a sample of programs would have required the firms to raise $8.5 billion (50 percent of their 1985 equity). (See MAC Group, *Impact on Defense Industrial Capability of Changes in Procurement and Tax Policy 1984–1987*, pp. 8 and 9 for tables displaying these changes.)

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

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

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

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

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

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

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

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

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

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

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

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

[64] Ibid., p. 28.

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

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

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

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

THE RESTRUCTURING PERIOD: 1991–2007

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

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[65] Ibid., p. 27.

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

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

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

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

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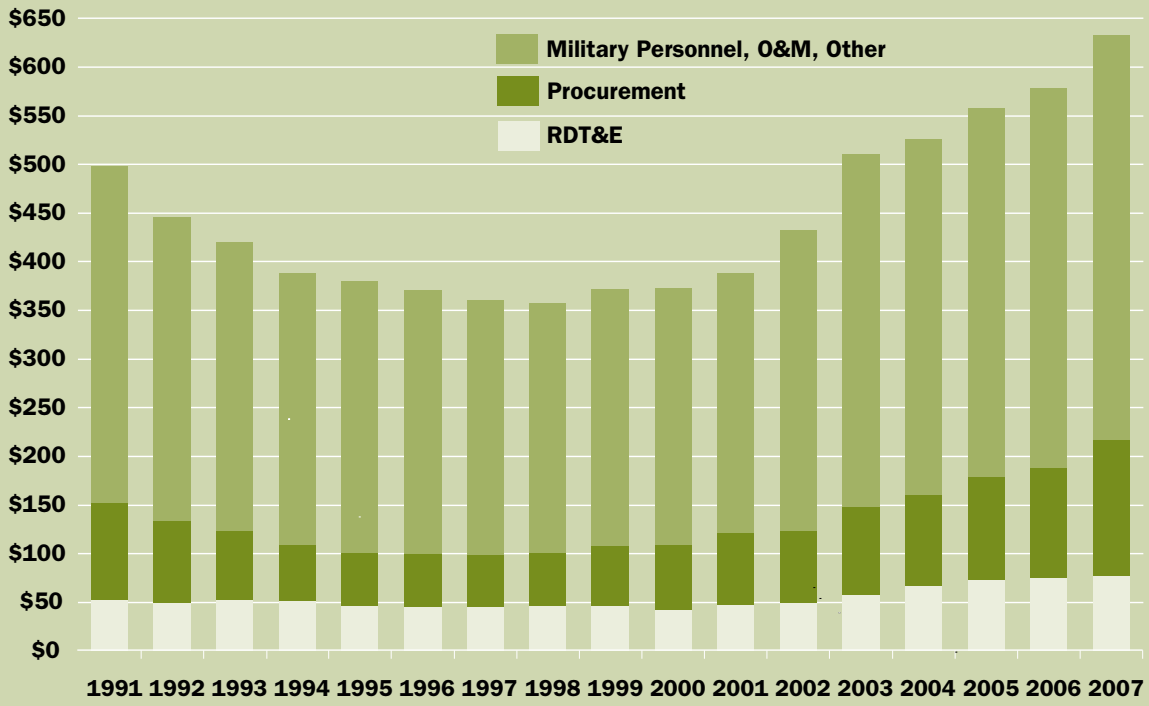
[67] Even the briefest survey of DoD's major acquisition programs argues that the US military Services still believe that the key to being a great power resides in leadership in domains such as air warfare, mechanized land combat, power projection, and "blue water" maritime power.

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

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[74] Ibid., p. 44.

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

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

[77] Ibid., p. 23.

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

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

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

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

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

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78 Ibid., pp. 23, 24.

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

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

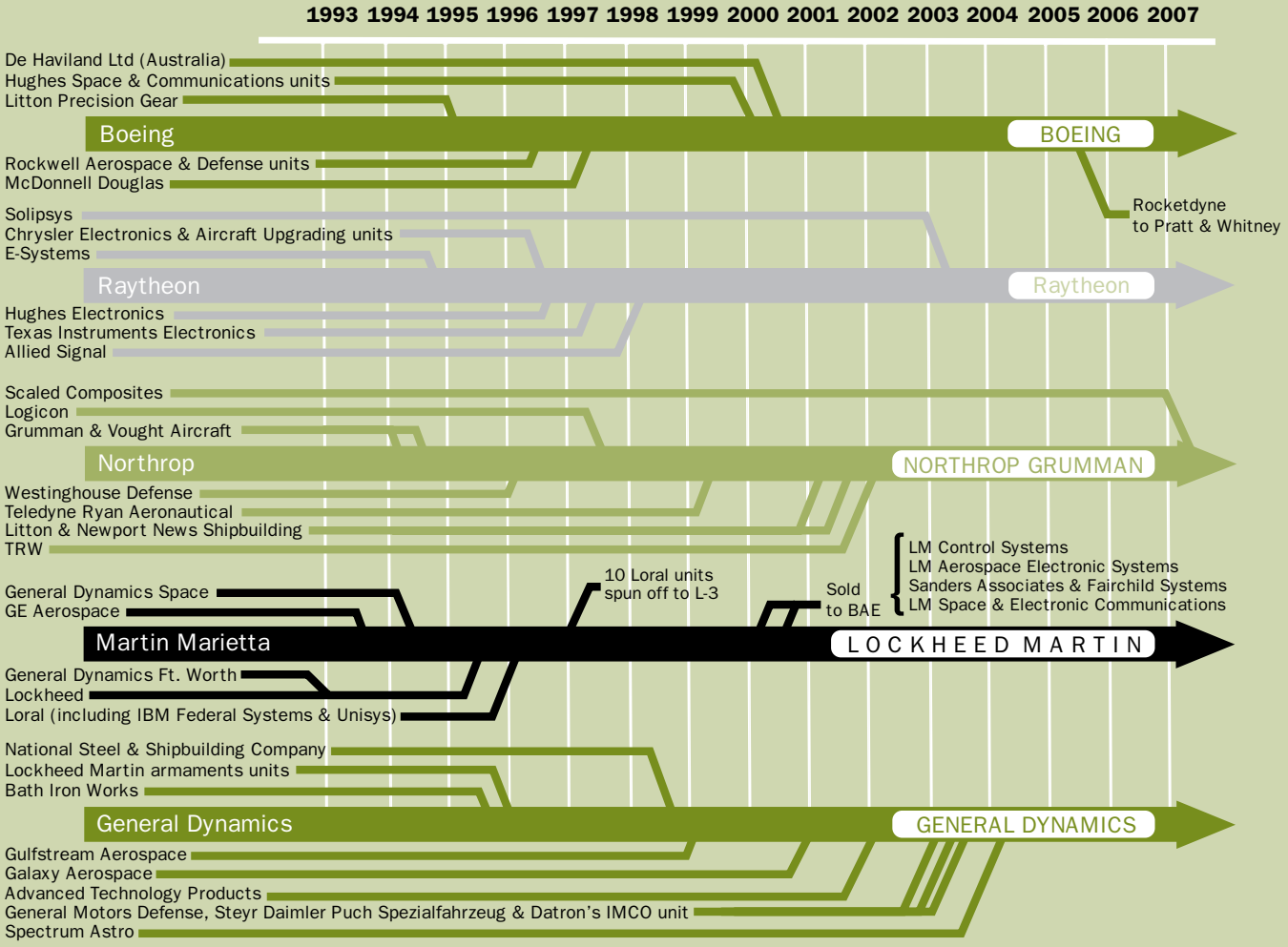
81 CSIS, "The CSIS Senior Policy Panel on the Future of the U.S. Defense Industrial Base," p. 20.

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

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

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

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



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

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

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

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

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

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

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

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

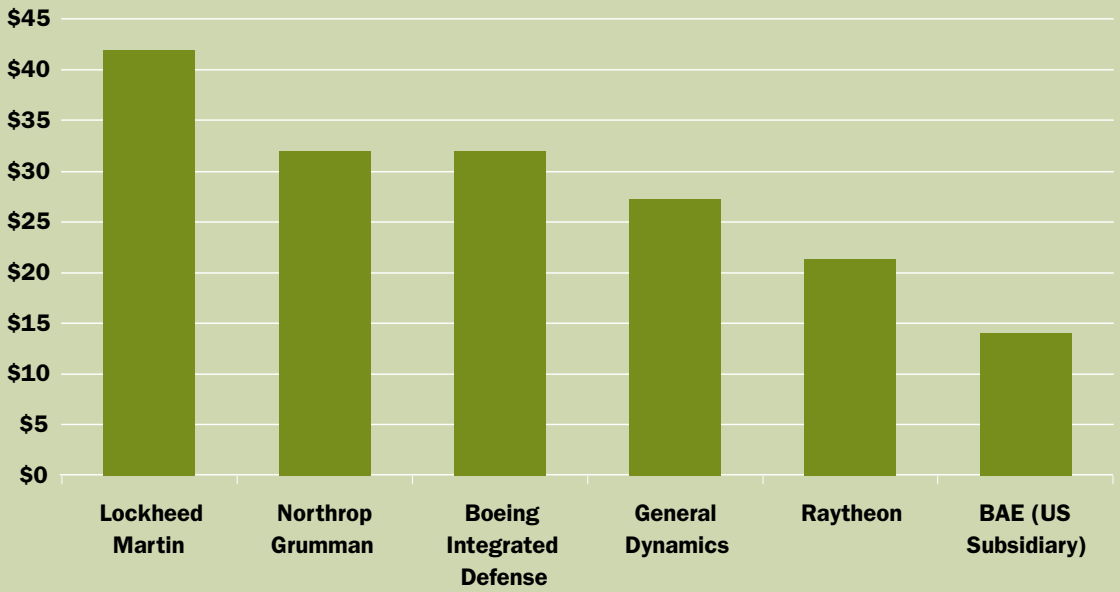
The national defense industries in Western Europe underwent similar consolidation:

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

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

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

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



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

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

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

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

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

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

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

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

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

92 Ibid., Slide 6.

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

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

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

THE US DEFENSE INDUSTRY TODAY

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

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

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

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

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

> MANNED, FIXED-WING COMBAT AIRCRAFT: The 1990s saw aircraft primes such as Martin, General Dynamics, McDonnell Douglas, North American and Rockwell International absorbed into two major firms, Boeing and Lockheed Martin. These consolidations created a duopoly of manned aircraft manufacturers. Lockheed appears to be the leader in high-performance combat aircraft, having won both the F-22 and F-35 programs while Boeing produces only the F-18E/F (due to end production in 2011–2012). Boeing leads in large support aircraft (e.g., the C-17 and the KC/RC-135 series of tankers and surveillance aircraft), but the KC/RC-135 aircraft have not been produced for decades and the C-17 is at the end of its production run. Northrop Grumman, however, is not yet out of the running as a third supplier of advanced combat aircraft. In February 2008 Boeing lost the competition for a new aerial-refueling tanker to Northrop Grumman, teamed with the European Aeronautic Defence and Space Company (EADS).[97] Subsequently, Boeing protested the Air Force's decision, GAO's audit of the selection process supported the protest, and the Air Force has announced that the contract will be re-competed. Northrop Grumman's last prime combat aircraft program was the B-2, which began full-scale engineering development in 1983, only delivered twenty-one of the stealth bombers to the Air Force.[98] Despite this setback — as well as the loss of the Advanced Tactical Fighter competition that led to the F-22 in 1990 — today Northrop Grumman has become the leading prime for DoD's unmanned air combat vehicle developments.

> ARMORED VEHICLES: In the 1990s lead US producers of armored vehicles such as Chrysler Defense, General Motors Defense, Teledyne Vehicles and United Defense were absorbed by General Dynamics and BAE Systems' American subsidiary. General Dynamics produces the Army's M1 main battle tank and leads in the development of the Army's Future Combat Systems (FCS), which includes a number of new land combat vehicles. GD has also acquired foreign manufacturers of armored fighting vehicles to build a worldwide presence in this product market. BAE produces the US Army's standard armored personnel carrier, the M2 and M3 Bradley. Like GD, BAE has sought to build a worldwide presence in armored vehicles, but has had some acquisitions blocked by local governments (e.g., the United Kingdom refused to permit BAE to buy Alvis, which had already acquired Vickers). Thus, a duopoly appears to exist in this segment of the defense industry, although a number of companies have teamed to bid for the lighter weight armor vehicles to protect soldiers from improvised explosive devices (IEDs) in Iraq.

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

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

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

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

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

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

[100] Ibid., p. 22.

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

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

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

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

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

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

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

> defense-unique culture and have never corresponded with the best business practices of the private sector. This cannot and will not continue.
>
> This Defense Reform Initiative reflects the insights of numerous business leaders who have restructured and downsized their corporations and not only survived but thrived in a rapidly changing marketplace. One major corporation whose top leadership team generously spent an afternoon with Deputy Secretary Hamre and our defense reform task force has adopted the motto "Strength with Speed," emphasizing that winning in the new era depends as much on the ability to respond quickly to new threats and opportunities as on the ability to overpower competitors head-on. US military forces have learned the same lessons, but they will not reach their full and necessary potential unless the business side of DoD marches in lock-step.[103]

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

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

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

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

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[103] William S. Cohen, *Defense Reform Initiative Report*, November 1997, "Message from the Secretary."

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

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

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

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

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

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

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

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

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

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

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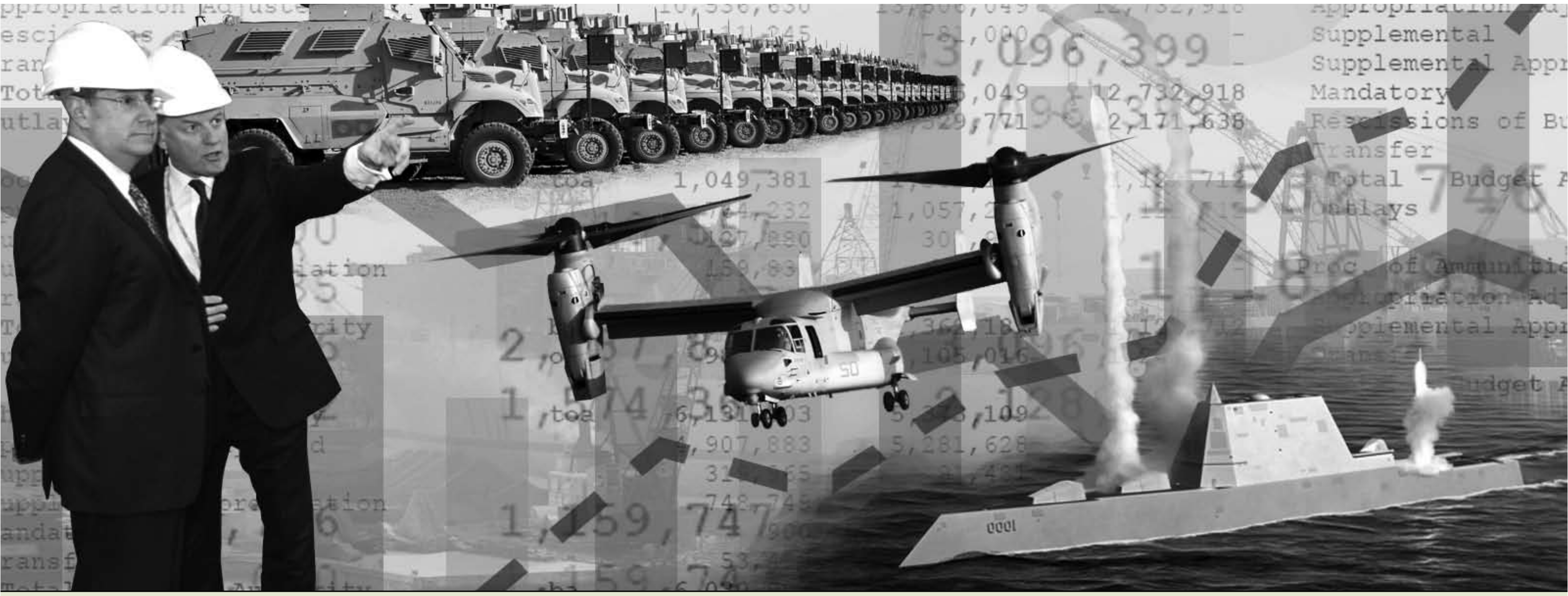
[106] While businesses within these firms may maintain an enthusiasm for the systems they build (as has been said, for example, of people who build warships and aircraft), ultimately the willingness of their corporation to sacrifice shareholder interests and opportunities is limited. Moreover, the number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

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

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

industry against all the other opportunities available in the market place. Over the last couple decades years it appears to have been losing that competition.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CHAPTER 2 > **DEFENSE INDUSTRY PERFORMANCE**

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

INDUSTRY SUPPORT OF US MILITARY STRATEGY

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

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

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

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

TABLE 1. **INDUSTRY PERFORMANCE SUMMARY**

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

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

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

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

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

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

[110] Frank W. Ault, "The Ault Report Revisited," The Hook, Spring 1989, p. 36.

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

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

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

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

PRODUCT AND SERVICE PERFORMANCE

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

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

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

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

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

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

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

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

> As much as 40 percent of program cost overruns can be correlated to changes in annual buys imposed by top-level members of the DoD/Executive branch or Congress. These factors are generally beyond the control of government or industry program managers.[119]

> Significant percentages of cost overruns result from discrepancies or shortfalls in the program's initial baseline requirements. The need for such changes can be legitimate responses to evolving threats and enemy capabilities. They can also reflect bureaucratic difficulties such as the lack of coordination or foresight within the government or contractor team. To cite a current example, the troubled VH-71 program to field a new presidential helicopter has reportedly suffered nearly 2,000

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

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

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

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

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[120] Gayle S. Putrich, "New Presidential Helicopter on Hold," *Marine Corps Times*, December 21, 2007.

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

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

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

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

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

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

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

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

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

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

It is notable that neither the US government nor the defense industry appears to have embarked on a long-term, continuous-improvement effort to control acquisition cost growth. Episodically, the government has tried various techniques including cost-sharing formulas for overruns, fixed-price contracting (including fixed-price engineering developments[129]), and acquisitions based on "Best Value" or "Cost as an Independent Variable (CAIV)." Little success in curbing costs has been achieved. Indeed, the problems may have grown worse since the 1990s. The Government Accountability Office's latest survey of major defense acquisition programs (MDAPs) indicated that from FY 2000 to FY 2007 acquisition cost growth increased from 6 percent to 26 percent across the portfolio, and average schedule slippage grew from sixteen months to twenty-one months.[130] The current data on cost growth, therefore, is worse than the roughly 20 percent RAND found in the 1960s. Further, of the ninety-six programs in GAO's FY 2007 portfolio, not one "had proceeded through system development meeting the best practices for mature technologies, stable design, and mature production processes."[131] Although the government bears considerable responsibility for this situation, the defense industry is probably equally guilty. From the standpoint of containing cost overruns and schedule slippages, not all defense companies have sufficiently embraced state-of-the-art commercial management

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

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

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

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

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

[131] Ibid.," p. 4.

techniques such as Six Sigma[132] or other quality-improvement practices. Indirect evidence indicates at least some attention has been paid to this problem: managers have been relieved of their assignments and industry chief executive officers have spoken about making changes. However, no enduring solution seems to have been found. Perhaps, as some have suggested, the absence of effective efforts to better control cost and schedule stem from the simple fact that the existing acquisition system has, on the whole, produced superior weaponry, and those with vested interests in its product are reluctant to risk major changes.[133] Another possibility is that changing requirements make cost and schedule control much more difficult to achieve in defense programs than in commercial product developments.

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

SUSTAINING THE INDUSTRIAL BASE

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

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

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

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

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

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

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

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

[136] Industry interview by George E. Pickett.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

INDUSTRY OPERATIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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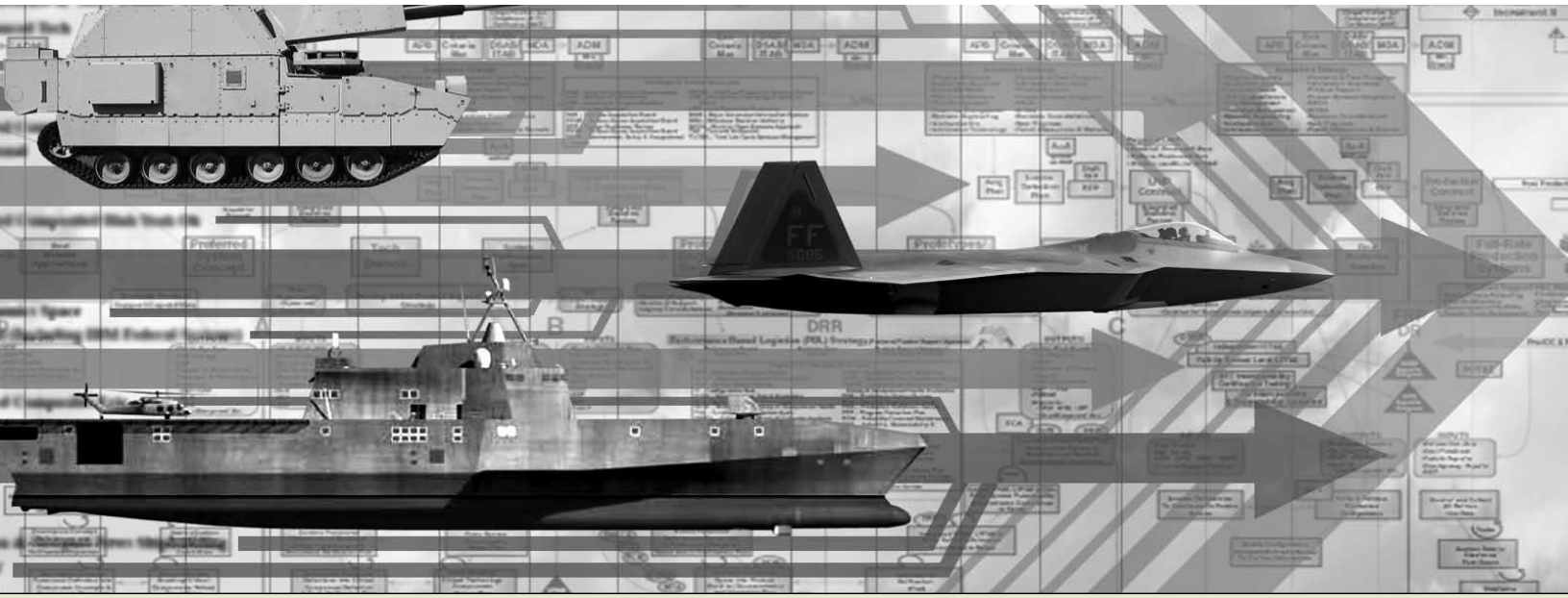
[151] Druyun retired from her position overseeing Air Force acquisition in December 2002 and went to work for Boeing. In the fall of 2003 Boeing fired Druyun amid investigations by the Justice Department, the Pentagon, and Congress into "whether she improperly or illegally entered into talks with a Boeing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

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

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



CHAPTER 3 > **INFLUENCING THE FUTURE US DEFENSE INDUSTRIAL BASE**

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

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

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

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

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

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

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

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

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

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

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

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

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

PRINCIPLES FOR DEALING WITH INCREASED UNCERTAINTY AND RISK

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

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

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

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

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

> MAKE HEDGING INVESTMENTS IN CAPABILITY AREAS WHERE THE CONSEQUENCES OF UNDER-INVESTING COULD BE SEVERE. Robotics, lasers, and biotechnologies for human physical and cognitive enhancements are all areas in which capabilities sufficiently disruptive to undermine current weaponry and ways of fighting could emerge. The challenge for the United States is to invest enough to avoid being surprised.

> DESIGN AS MUCH FLEXIBILITY AND CAPACITY FOR ADAPTATION OR EXPANSION INTO WEAPONS AND FORCES AS POSSIBLE. The history of US military practice is replete with examples of systems and platforms being procured with specific uses or missions in mind and eventually being adapted to different uses and missions. The venerable B-52 bomber was procured as a strategic-nuclear delivery platform but within the last decade has been used for the direct support of ground forces. During the Cold War American nuclear attack submarines were designed first and foremost to sink enemy naval combatants but perhaps had their greatest utility as intelligence platforms. In light of growing uncertainty and risk, this sort of flexibility and adaptability is likely to be even more crucial in the future, but such capacities have rarely been sought during weapons development. Note, though, that the desired flexibility and adaptability depends as much, if not more, on the underlying intelligence, skills, and mindsets of the US military as it does on designers and engineers in defense companies. At the same time, top-quality engineering talent, processes, and tools within the companies will also be needed.

> EMPHASIZE UNDERLYING TECHNOLOGIES AND CAPABILITIES APPLICABLE ACROSS MANY AREAS OF POTENTIAL IMPORTANCE. Software has become an increasingly ubiquitous and critical component of modern weapon systems. By the late 1990s, IBM/Loral was maintaining approximately two million lines of code for the Space Shuttle's flight control system. The F-35 JSF will have "about six million lines of code in the airplane and another six million in the simulator, plus about three million in associated systems."[160] Turning to military capabilities, the US military has been moving steadily toward networked systems. They require both secure

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

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

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

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

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

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

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

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

SHAPING VERSUS STRUCTURING THE DEFENSE INDUSTRY

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

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

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

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

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

[164] Ibid.

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

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

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

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

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

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

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

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

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

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

ACCESSING COMMERCIAL TECHNOLOGIES, CAPABILITIES, AND PRODUCTS

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

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

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

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

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

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

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

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

[173] Ibid., p. 4–25.

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

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

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

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

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

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

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

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

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LOW-VOLUME PRODUCTION VERSUS SURGE CAPACITY

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

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

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

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

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

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

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

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

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

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

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

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

GOVERNMENT MANAGEMENT AND BUYING PRACTICES

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

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

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

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

- ALTERING BROAD DEFENSE REQUIREMENTS IN RESPONSE TO CHANGES IN THREAT CAPABILITIES AND THE INTERNATIONAL SECURITY ENVIRONMENT. Since the Cold War ended, the US Navy has increased its interest in littoral operations, as evidenced by the introduction of the Littoral Combat Ship. An even more consequential change, flowing from 9/11, is the November 2005 DoD Directive (DoDD) that established declared stabilization, security, reconstruction, and transition operations leading to sustainable peace as a "core U.S. military mission."[184]

- CONTROLLING THE MERGER AND ACQUISITION OF COMPANIES BY US DEFENSE firms as well as influencing the building of alliances and formation of teams within the industry and the access of foreign firms to the US defense market and military technologies.

- INTRODUCING NEW MANAGEMENT PRACTICES THAT ALTER GOVERNMENT-INDUSTRY RELATIONS OR REQUIREMENTS THAT AFFECT SYSTEM DESIGNS. Recent examples include using private-sector Lead System Integrators (LSIs)[185] to execute large, complex acquisition systems such as the Army's Future Combat Systems and the Coast Guard Deepwater development, and growing emphasis in defense programs on design standards for interoperability, standardization, and the use of commercial best practices.

- MAKING CHANGES IN BUDGETING AND FUNDING PRIORITIES. Examples include President Bush's decision to end B-2 production at twenty aircraft, or the rapid growth in UAVs for real-time battle-space reconnaissance since 2001. A less obvious and longer-term instance of changing government priorities in defense acquisition is the declining importance of platforms compared to precision-guided munitions (PGMs) and the growing importance of sensor networks compared to PGMs.

- AFFECTING THE COMPETITIVENESS OF ACQUISITION PROGRAMS BY CHANGING the frequency of opportunities (especially new starts), managing potentially dysfunctional competitions, maintaining parallel providers, and sustaining some degree of competition over the life of major programs by such techniques as qualifying second sources and competing later lots.

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

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

> CHANGING THE METRICS FOR SOURCE SELECTION AND PROGRAM PERFORMANCE. Examples include taking into account the long-term effects on the defense industry of a given program award or making total ownership cost (TOC) a key performance parameter (KPP).[186]

> AFFECTING THE INTERNAL OPERATIONS OF DEFENSE FIRMS. Ongoing illustrations are the imposition of special reporting and accounting systems on defense programs, requiring onsite presence by government program officials, restrictions on the overseas sales of particular weapons, and the government's handling of industry proprietary knowledge.

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

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

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

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

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

CONCLUSION > **STRENGTHENING THE INDUSTRIAL BASE**

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

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

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

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

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

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

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

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

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

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

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

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

[189] Ibid., pp. 63, 65, 69.

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

capabilities remained "subject to adequate competitive forces, a key to efficiency and innovation."[191]

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

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

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

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

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

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

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

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

> . . . Our assessment is that the culture of the Department is to strive initially for the 100 percent solution in the first article delivered to the field. Further, the "conspiracy of Hope" causes the Department to consistently underestimate what it would cost to get the 100 percent solution. Therefore, products take tends of year to deliver and cost far more than originally estimated.
>
> There is a need to shift to Time Certain Development and make "schedule" a Key Performance Parameter. Developmental programs must change their focus to deliver useful military capability within a specified time (nominally no more than six years for major platforms) from Milestone A.[195]
>
> Time Certain Development enforces evolutionary acquisition by making time the focus of the up front requirement statement. Capabilities could be upgraded over time as technologies mature and operational requirements become clearer. Time Certain Development differs from prior attempts at valuing time to market, such as evolutionary acquisition and spiral development in that a maximum number of years is mandated, the start and end dates are defined, and the driving processes (requirements, budget, source selection, etc.) are revamped to support it.[196]

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

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

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

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

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

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

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

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

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

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

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

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

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

and Development System (JCIDS) in June 2003.[200] Nevertheless, the new JCIDS requirements process, the DoD acquisition system, and the Planning, Programming, Budgeting, and Execution (PPBE) system remain fixated on individual programs and their costs rather than on capability portfolios. Nor is there any appreciable evidence of a shift toward a time-based approach such as DAPA's Time Certain Development. Presumably, a capabilities-based approach would encourage acquisition decisions to be made with an eye toward broad military needs rather than individual systems, and this perspective could, over time, encourage government officials to pay more attention to ensuring that the industrial base supplying those capabilities remains an enduring source of advantage for the United States. Unfortunately, DoD's endorsement of a capabilities-based approach appears, so far, to be mostly rhetoric. The substantive changes to longstanding acquisition practices, directives, instructions, and regulations that concentrate remorselessly on individual programs and costs have yet to materialize.

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

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

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

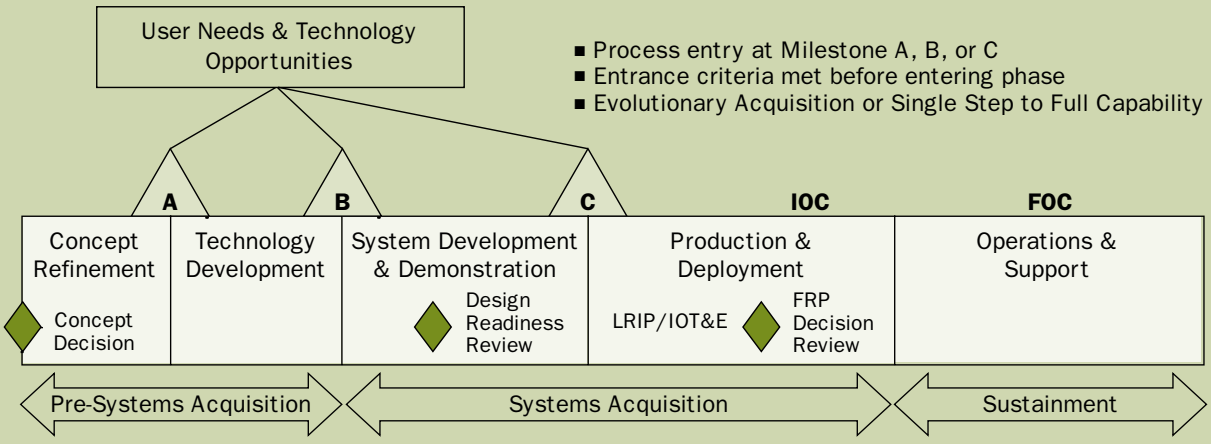
[201] CJCSI 2170.01F, "Joint Capabilities Integration Development System," pp. 1–2.

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

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

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

FIGURE 7. **THE FORMAL DOD ACQUISITION MANAGEMENT SYSTEM***



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

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

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

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

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

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

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

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

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

> REQUIRE COMPANIES TO CONDUCT NO-HOLDS-BARRED "LESSONS LEARNED" ON MAJOR PROGRAMS. Relentless pursuit of mistakes and their correction have been emblematic of very successful firms across many industries. Defense companies should be forced to join those ranks. The proprietary company knowledge that might be revealed in the process can be protected. A firm's demonstrated ability to learn from it past failures, as well as successes, could even be used as criteria in selecting winners in future competitions.

> MAKE THE LONG-TERM IMPACT ON THE INDUSTRIAL BASE AN EXPLICIT SOURCE-SELECTION CRITERION. There is little doubt that, informally at least, individual source-selection authorities have tried to consider the influence of the competition's outcome on the industry as a whole as a factor in deciding the winner. Will the losers be inclined to exit the defense business or eliminate unique capabilities that the military may need later? Only by making the impact on the industrial base a formal selection criterion are such considerations likely to become the rule rather than the exception.

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

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

Acknowledgments

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

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STRENGTH THROUGH INDUSTRY & TECHNOLOGY

PROMOTING NATIONAL SECURITY SINCE 1919

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
MANUFACTURING DIVISION

MAINTAINING A VIABLE DEFENSE INDUSTRIAL BASE

AUGUST 1, 2008

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Preface

The origin of the National Defense Industrial Association (NDIA) dates back to 1919 with the formation of the Army Ordnance Association, which was later renamed the American Defense Preparedness Association (ADPA). With the merger of ADPA and the National Security Industrial Association (NSIA) in 1997, NDIA has become America's leading defense industry association promoting national security. NDIA is a non-partisan, non-profit, educational association located in Arlington, VA.

NDIA's mission is to advocate cutting-edge technology and superior weapons, equipment, training and support for the Warfighter and First Responder; promote a vigorous, responsive, Government-Industry National Security Team; and provide ethical forums for the exchange of information between industry and Government on National Security issues.

The Association's membership consists of companies and individuals from the broad spectrum of the defense and national security industrial base. Corporate member representatives are organized into thirty-two functionally oriented Divisions that serve as the vehicles by which NDIA brings attention and focus to a wide variety of defense industrial base sectors. NDIA's Manufacturing Division focuses its interests and actions on enhancing the security of the United States by promoting interaction and collaboration between government and industry in the vital areas of manufacturing research, design, development, test, technology and production.

Specifically, NDIA's Manufacturing Division:

- Advocates national support for defense manufacturing
- Promotes defense manufacturing excellence
- Supports promising manufacturing technologies, processes, and implementation methodologies
- Supports efforts to educate, recruit, and train a highly skilled defense manufacturing workforce
- Conducts government-industry forums focused on defense manufacturing
- Conducts research and analysis on manufacturing trends and policies

NDIA's Manufacturing Division has prepared this document to inform U.S. leaders of the current issues facing U.S. manufacturing, and the effort needed for the U.S. to maintain a strong defense manufacturing base, capable of surging to meet our Nation's needs in times of crisis.

Sincerely,

Lawrence P. Farrell, Jr.
Lieutenant General, USAF (Ret.)
President and CEO

Cover Graphics

NDIA Manufacturing Division wishes to acknowledge the organizations listed below for the manufacturing images employed on the cover of this document.

American Competitiveness Institute

Association for Manufacturing Technology

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National Center for Manufacturing Sciences

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Executive Summary

The Manufacturing Division of the National Defense Industrial Association (NDIA) works to ensure the U.S. defense manufacturing industry is capable of providing critical supplies and equipment needed by our warfighters and first responders. This is particularly challenging in today's dynamic business environment. It is important that our federal government policy makers understand these dynamics and implement effective policies to maintain U.S. superiority. Serious manufacturing-related issues impacting U.S. defense industry include:

1) Manufacturing Technology. The U.S. must continue to develop and implement advanced process technology to enable new product development and promote greater productivity. Technology is the key to U.S. manufacturing superiority in the 21st century. Increasing the DoD ManTech budget is a start, but providing more funding for process development and providing incentives to encourage industry adoption of new technology is also a necessity.

2) Lack of a Skilled Manufacturing Workforce. The manufacturing workforce is aging. Help is needed to attract, educate, and retain future generations of skilled manufacturing workers. Programs are needed to encourage and promote manufacturing, especially defense manufacturing, as an important, respected and desirable career path.

3) DoD Supply Chain. Original Equipment Manufacturers (OEMs) are becoming systems integrators and relying more on a global supply chain. The key technologies and components needed by OEMs for increasingly complex weapons systems require development of new ways to communicate with an ever expanding supply chain.

4) Modernization of Defense Manufacturing Facilities. U.S. defense industry manufacturing facilities, especially government-owned facilities, often employ aged processing equipment and methods. Many foreign nations like India and China, are installing modern process technology as they build new manufacturing facilities. Investment is needed in U.S. defense industry facilities to improve our production capability and assure timely delivery of supplies and equipment needed by our warfighters.

5) Global Competition. Globalization is here and U.S. companies are competing against companies all over the world that have lower labor costs, the most modern processing equipment, and government policies that create an uneven playing field. We must encourage U.S. companies to invest in defense manufacturing infrastructure, and create a business environment that will help them compete on a global basis.

6) Manufacturing and Local Economies. Manufacturing employment has declined by over eight million jobs (36.3%), in the last twenty years. Today, there are 14 million manufacturing jobs across the U.S. - the same number we had when Harry S. Truman was President. Manufacturing jobs support a disproportionate share of local economies, making them a vital ingredient to healthy cities and towns across the U.S.

7) Environmental Protection. Defense industry is aware of the need to care for the environment and has responded. Industrial efforts are addressing the need to reduce hazardous elements, like Cadmium, Chromium and Lead. In addition, industry is pursuing alternative energy sources

and reduced energy consumption, and decreasing their environmental footprint and dependence on foreign energy sources. A key current challenge for industry is legislation mandating the elimination of certain materials from production prior to the availability of viable alternates, such as the elimination of the use of lead in solder for electronics.

Key Issues

I. Manufacturing Technology

Position: If we lose our preeminence in manufacturing technology, then we lose our national security. The U.S. must accelerate its development of new innovative manufacturing technologies and processes. This is the only thing that will allow us to enable product development and maintain a competitive industrial base. NDIA calls for the creation of an environment that promotes collaboration and that fosters development of innovative manufacturing methods, just as has been done for basic and applied research across the sciences. NDIA supports implementation of the recommendations contained in the February 2006 Report of the Defense Science Board Task Force on DoD Manufacturing Technology (ManTech).

Background: If we are to maintain the best fighting capabilities, our warfighters must be continually supplied with products of the highest performance and reliability. This will not happen without continuous advancements in manufacturing technology. Foreign firms and an increasing number of U.S. multi-national companies are gaining competitive advantage in collaborative innovation and commercialization research outside the United States. This presents a fundamental challenge to U.S. defense manufacturing competitiveness, as well as domestic manufacturing capabilities in other sectors.

Techniques used to manufacture products in the past are not capable of producing the latest defense and commercial products designed with new advanced materials, more complex shapes, and to more exacting tolerances. In many cases, new products are possible only through advanced manufacturing technologies, which can enable higher temperature, lower weight, or increased protection. In short, manufacturing technology is an enabler that must precede or be aligned with product development, starting with defining the product requirements.

There is strong consensus in industry, academia, and government that future U.S. manufacturing competitiveness will be primarily determined by how quickly new technology is integrated into high-value-added products and high-efficiency processes. Development of manufacturing technology has become more systems based and interdisciplinary, and therefore must be considered at the beginning of the product development cycle and continually addressed throughout all phases of the product lifecycle. To accomplish this, manufacturing readiness level (MRL) metrics for manufacturing process maturity have been developed and piloted in Science & Technology (S&T) and Acquisition programs, and now it is time to implement them across the Department of Defense and defense industry.

Commercial businesses are not positioned to successfully invest in long-term, high risk research activities by themselves, especially for defense manufacturing technologies. Venture capital has shifted its attention to short-term scalable projects. Federal funding typically does not support critical research beyond the "valley of death" and through commercialization. This shortcoming has been identified numerous times in the Small Business Innovation Research (SBIR) program, in our Federal Laboratories, and from a variety of university research programs. Today, it is more important than ever support and incentivize manufacturing technology advancement.

Recommendation: Specific manufacturing technology recommendations include:

1. Intensify efforts to establish and support advanced collaborative activities between federal, state and local governments, and consortiums, universities and commercial businesses that will promote defense manufacturing-focused innovation and advance the commercial manufacturing capability of the United States. Consider best practice models, such as the Rolls Royce partnership with the University of Sheffield and the British Government.[1]
2. Revive the joint-service Advanced Manufacturing Enterprise (AME) subpanel within the DoD ManTech program to manage collaborative research for "above the shop-floor" initiatives such as Model Based Manufacturing, Global Collaborative Manufacturing, Network Centric Manufacturing, and Sustainable Manufacturing.
3. Require the use of Manufacturing Readiness Levels to assess production risk at all milestones, and include manufacturing considerations in the DoD Acquisition Process from requirements through disposal.
4. Balance the S&T (product technology) investment with appropriate manufacturing process technology investment, as described in the 2006 DSB report on DoD Manufacturing Technology.
5. Emphasize the importance of measurements and standards (e.g. NIST) for adopting new manufacturing technologies, such as for nano-technology initiatives and collaborative model-based manufacturing.
6. Require consideration of manufacturing readiness technology criteria in all military logistic decisions and operations to ensure warfighters and first responders receive only the best and most sustainable equipment.

II. Manufacturing Workforce

Position: A highly skilled workforce is the lifeblood of any successful company, industry, or national economy. The majority of manufacturing companies in the U.S. now report a moderate to severe shortage of qualified engineers, scientists, technicians, and skilled production employees. The vast majority of created jobs in the future will require technical skills beyond the high school level; those same skills which are currently in short supply. An inability to fill these positions with skilled employees will contribute to the decline of the United States as a world economic power and the eventual decline in the standard of living of many U.S. citizens.

Background: In addition to the increasing demand for a skilled workforce, there are serious issues on the supply side of the workforce equation. The trend is getting worse as our older workers are not staying in the manufacturing workplace and our youth are not going into it at all. Adding to the problem, the U.S. education system is not keeping pace with the knowledge and skills necessary to compete in the 21st century global economy. Worse yet, more than 30% of ninth graders drop out

[1] See web page http://www.sheffield.ac.uk/business/portfolio/rr.html

from school prior to graduation. Only 18% eventually graduate from college and only half of those will receive technical degrees.

The manufacturing workforce in the United States stands at just over 14 million people, 25% less than it did 25 years ago. Over 50% of the workforce decline can be attributed to just 6 of the 27 business sectors: Apparel, Fabricated Metal Products, Machinery, Computer, Electronic Product, and Transportation Equipment. Each of these industries is critical to supporting our warfighters. If we do not manufacture the products, then we will not be in position to improve them. If we do not improve our current products, we will lose our technological preeminence. Increased emphasis is needed to attract, educate, and retain skilled workers.

Recommendation: In addition to the initiatives currently sponsored by industry, the federal government should:

1. Increase federal support of STEM (Science, Technology, Engineering, & Math) education initiatives.
2. Require school systems to enhance career counseling of all middle and high school students on their options for entering post-secondary education and/or the workforce.
3. Provide federal scholarships to students/workers pursing manufacturing engineering degrees and willing to work in a manufacturing environment for at least three years after graduation.
4. Include manufacturing workforce development criteria in the source selection evaluation process for federal contracts.

III. DoD Supply Chain

Position: We must transform the U.S. manufacturing supply chain with a Network Centric Manufacturing capability in order to preserve our national security.

Background: The world of the 21st century is indeed a Flat World. The impact of Globalization on U.S. manufacturing has been dramatic and devastating. It has contributed to the 3.5 million jobs lost in the manufacturing sector over the last seven years alone, and more importantly poses a threat to our National Security. For with each lost manufacturing job, our defense manufacturing capability declines. Today, the U.S. depends on other nations, who are not necessarily our friends, for strategic materials and technology. This is not an acceptable position for the United States of America.

In 2005, a report from the National Academy of Science said, "Americans are feeling the gradual and subtle effects of globalization that challenge the economic and strategic leadership enjoyed by the U.S. since World War II." In 2008, those effects are no longer subtle or gradual. They represent a real and present threat to our National Security by jeopardizing the long-term technical superiority of our weapons systems.

In March 2006, the General Accounting Office issued a report on the challenges faced by DoD in managing its supply base which states, "Changing security threats, rapidly evolving science and technology, and budget imbalances have created an uncertain acquisition environment." The problem exists on both sides, with the customer and with the supplier.

From the supply side, the transformation in manufacturing has already begun. OEMs are becoming integrators of systems and subsystems, which are not just manufactured by the supply chain, but increasingly are invented, designed and developed by other companies. Therefore managing the supply chain is becoming more complex and requires a total enterprise approach, or "Network Centric Manufacturing."

Network Centric Manufacturing takes full advantage of innovations from all tiers in the Supply Chain as well as from OEMs, integrators, universities, and the customer. It enables innovation throughout the extended enterprise and across the total life cycle of products ranging from complex systems to legacy parts.

Network Centric Manufacturing consists of "an enterprise capability that is customer focused and information based, one which embraces innovation, builds from the best commercially available capabilities, promotes appropriate competitiveness, and is resistant to many kinds of disruption." This approach requires a view of manufacturing that must include systems analysis, advanced manufacturing technologies, and culture and behavior changes. To facilitate and encourage this change, a number of new and creative programs and funding must be put in place to serve both the general economy and the defense manufacturing enterprise. The achievement of this objective requires political leadership of the highest order.

Recommendation: Establish a federally mandated Blue Ribbon Panel to report within 6 months on a series of initiatives to address those actions required to improve the agility, competitiveness and viability of the general manufacturing industry in the United States with particular emphasis on defense manufacturing and national security considerations.

IV. Modernization of DoD Manufacturing Facilities

Position: The U.S. must continually invest to modernize facilities that produce, repair and/or maintain equipment and supplies critical to our warfighters and first responders. No other nation on earth leaves this burden strictly on the commercial sector of the economy. The government must act to promote a favorable business environment for those industries which constitute the DoD supply chain, and thereby facilitate investment that enables companies to be globally competitive.

Background: Today, there are large numbers of facilities that are government-owned and government or contractor operated, including numerous Army and Air Force depots, Navy shipyards, and munitions plants. However, the infrastructure of many of these facilities is antiquated, requiring significant investment and upgrade in order to appropriately service the needs of today's U.S. military. Much of the equipment being used to manufacture or repair equipment critical to the warfighter was originally built and installed decades ago. As an example, the 10 government-owned and contractor operated (GOCO) ammunition plants have structures and equipment that were originally installed in the decade following WWII. Navy shipyards and DoD depots are in a similar situation.

To remain globally competitive, U.S. companies must continually invest in modern manufacturing infrastructure. Driving productivity up, reducing labor hours, and increasing efficiency is critical to

remaining globally competitive. Private industry recognizes that without planned periodic capital investment it cannot compete against aggressive, well-equipped international manufacturers.

Globalization is a fact and not a cliché. U.S. manufacturers compete against foreign companies with low cost labor operating the most modern equipment. Some countries, like China, emphasize (and even require) the use of new equipment, often subsidized by the government. Their production rates and quality are improving at an increasing rate. The U.S. must promote a business environment that incentivizes defense industry to invest in their defense manufacturing infrastructure.

Recommendation:

1. DoD and Congress must budget for, and commit to, long-term funding in order to support and maintain manufacturing excellence within government-owned manufacturing facilities.
2. An Industrial Modernization Incentive Program (IMIP) for capital investments must be revisited and updated to reflect changing global market conditions.
3. A mechanism must be introduced that offers favorable interest rates, tax breaks, and other incentives to companies prepared to invest in the procurement of state-of-the-art manufacturing equipment.
4. A nationally recognized program to reward defense suppliers that invest in modernization should be introduced and linked to a "Score Card" to be considered during Source Selection and Evaluation.
5. The opinions of industry participants in government-owned facilities should be given more "formal" weight in decision-making processes related to the military industrial base.

V. Globalization

Position: Globalization is here and U.S. manufacturers are competing against foreign companies, many of which have lower labor costs, are utilizing the latest (government sponsored) technologies, and are operating within foreign states that do not share the same policies as the U.S.

Background: Globalization is viewed as both good and bad for U.S. manufacturers. Many large U.S. companies see globalization as expanding markets, yielding more opportunity to drive overall revenue growth. The large companies also view globalization in the context of an opportunity to expand their outsourcing, which provides additional competitive pressure to keep supply chain costs low.

For manufactures participating in the supply chain of global companies, globalization can be a concern. Globalization often means competing against companies with lower labor cost, which is common throughout the Asia Pacific area including China and India. Companies in these areas often have new facilities with the most advanced process technology. Further, many of these countries do not operate on a level playing field with the U.S. with respect to government policies and currency.

Although globalization is viewed in different ways by industry, the U.S. government and military must not underestimate the impact it has on defense manufacturing. Currently, many components needed for today's weapons systems come from overseas. It is critical that manufacturing capability

needed to build, repair, and maintain strategically important weapons systems remains in the U.S. and not be subject to influence of foreign government leaders.

Recommendation:

One thing that is common between both large and small U.S. manufacturing companies is the belief that we can compete with any foreign company in the world if the playing field is level. To ensure the playing field is level we recommend the following:

1. Viable Foreign Corrupt Practices Act compliance certification. Not all foreign companies that sell products in the U.S. or compete with U.S. firms are subject to the Foreign Corrupt Practices Act.
2. Promote foreign states to allow their currency to float. Some countries, such as China and Japan, do not allow their currencies to freely float on the open market. This creates an uneven competitive environment.
3. Manufacturing is a significant consumer of energy, and securing a sufficient and reliable supply of energy that is competitively priced is vital to the industry.
4. ITAR revisions to support U.S. manufacturers and friendly nations are desperately needed.

VI. Manufacturing and Local Economies

Position: Manufacturing jobs are a key contributor to the health of local communities and therefore an essential ingredient to a thriving local economy. We must recognize the contribution provided by manufacturing businesses and ensure their long-term health to maintain vibrant local economies across the nation.

Background: Currently the manufacturing segments of the U.S. economy employ 14 million workers, which is nearly identical to that just after the end of WWII. The industry has seen a decline of over five million manufacturing workers from the peak in 1980, with over 3.5 million (about 20 percent) of the overall decline coming in this decade. This decline is the result of companies outsourcing manufacturing work to foreign countries and a continued increase in U.S. productivity.

Although overall employment has been on the decline, there is evidence that the demand for highly skilled employees is actually increasing, and that the decline in workforce is all from medium and low skilled labor. Technology and automation that has been replacing lower skilled labor requires a new generation of highly skilled personnel, thus increasing the demand.

The impact of this decline on local regions can be significant. Federal, state, and local governments must not underestimate the economic multiplier effect of well-paying manufacturing jobs on local economies. A 2003 report issued by The State of Kentucky's Cabinet for Economic Development (www.thinkkentucky.com) stated that every 100 new manufacturing jobs creates an economic ripple effect that creates an additional 159 indirect jobs and 153 induced jobs. These 412 employed persons pay federal, state, and local taxes, which vastly improves the tax base of a local economy. This is of great assistance to areas that are struggling financially.

Recommendation: With local budgets bursting from skyrocketing energy and food costs, we must reverse the downsizing trend of the American taxpaying workforce in our vital U.S. manufacturing industry.

1. Local regions must be prepared to help attract and train highly skilled manufacturing labor.
2. Federal government should assist state and local governments as they promote and train that workforce.
3. Require the utilization of price adjustment clauses in multi-year fixed price government contracts where inflation of prices for certain commodities (like petroleum products, or products which are dependent on the Euro) is driving companies out of business. Rather than leaving manufacturers strictly on their own, assist them when it is in the national interest to do so, as is true with many local manufacturers throughout the United States.

VII. Environmental Issues

Position: Government and industry must work better together to preserve the environment while maintaining the capability to manufacture critical defense components.

Background: Virtually all defense contractors have responded to the need for increased stewardship of the environment with strong corporate programs. Industrial programs focus on reduced use of hazardous materials in their products, with the ultimate goal of eliminating hazardous materials as technically viable alternative materials become available. Defense industry is also pursuing alternative energy sources and reduced energy consumption in order to reduce their environmental footprint and our collective dependence upon foreign energy sources.

A key current challenge to the industry is legislation outside of the U.S., coming particularly from the EU, that is mandating the elimination of certain materials from products prior to the availability of viable alternative materials that will meet the requirements of the end product, such as lead (Pb) in electronics and the use of primers and coatings containing hexavalent chromium (Cr+6) to prevent corrosion. Globalization of the defense supply chain and increasing reliance on commercial off-the-shelf (COTS) components subject to the EU legislation, especially for electronics, are making it difficult to obtain suitable products required to achieve the necessary system performance, reliability, and maintainability for U.S. defense weapons systems. EU legislation regarding Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) in electronics, and REACH (Registration, Evaluation, and Authorization of Chemicals) in some cases is resulting in the use of alternate materials that in fact have a more negative impact on the environment than the banned material. Replacement "lead-free" solder alloys have higher processing temperatures that consume additional energy than the traditional tin-lead (SnPb) solders, and are also less reliable, leading to increased scrap material entering the environment. Even more harmful to the defense industrial base is the uncertainty in the reliability of many replacement materials, which have been rushed into production to meet legislative constraints.

Recommendation: Due to heavy reliance on the global commercial market for raw materials, state-of-the-art electronics, and numerous other items, the federal government, working closely with industry, should:

1. Carefully monitor international environmental legislation being developed, assess the impact on U.S. defense weapons systems, and attempt to influence the content of the final legislation when necessary to protect our interests.

2. Provide focused investment in the development of alternative, non-hazardous materials that offer performance at least as good as the items containing hazardous materials.

3. Evaluate the need to establish trusted domestic sources of traditional products containing hazardous materials until technically acceptable alternate products become available.

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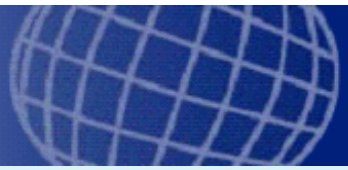


Briefing of the Working Group on the

Health of the U.S. Space Industrial Base and the Impact of Export Controls

February 2008

Preamble

- **"In order to increase knowledge, discovery, economic prosperity, and to enhance the national security, the United States must have robust, effective, and efficient space capabilities."**
  - U.S. National Space Policy (August 31, 2006).

Statement of Task

- **Empanel an expert study group to [1] review previous and ongoing studies on export controls and the U.S. space industrial base and [2] assess the health of the U.S. space industrial base and determine if there is any adverse impact from export controls, particularly on the lower-tier contractors.**
- **The expert study group will review the results of the economic survey of the U.S. space industrial base conducted by the Department of Commerce and analyzed by the Air Force Research Laboratory (AFRL).**
- **Integrate the findings of the study group with the result of the AFRL / Department of Commerce survey to arrive at overall conclusions and recommendations regarding the impact of export controls on the U.S. space industrial base.**
- **Prepare a report and briefing of these findings**

Working Group

- Thomas Young, Consultant, Co-Chair
- Bill Ballhaus, Aerospace Corp , Co-Chair
- Pierre Chao, Center for Strategic and International Studies, Co-Chair

- Richard Albrecht, Moog
- Jeffrey Bialos, Johns Hopkins
- Lincoln Bloomfield Jr., Palmer Coates
- David Danzillio, Emcore Photovoltaics
- John Douglas, Aerospace Industries Association
- Paul Kaminski, Technovation
- John Klineberg, Consultant
- Lon Levin, SkySeven Ventures
- Tom Marsh, Lockheed Martin, retired
- Tom Moorman, Booz Allen Hamilton
- J.R. Thompson, Orbital Sciences
- John Tilelli, Cypress International
- Robert Walker, Wexler & Walker Public Policy Associates

Methodology

- Leveraged broad set of interviews and data from:
  - US government
    - Department of State, Department of Defense (OSD/Policy, OSD/AT&L, DTSA, STRATCOM, General Council), NRO, Department of Commerce, NASA, FAA, GAO
    - Congress
  - Foreign governments and agencies (Asia and Europe)
  - US industry
    - Boeing, Lockheed Martin, Northrop Grumman, ATK, Moog, Swales, GeoEye, SES Americom
  - Other experts
    - IDA, Aerospace Corp., Booz Allen Hamilton, Satellite Industry Association, Space Foundation, US Chamber of Commerce, CSIS, Aviation Week
- Leveraged comprehensive survey of space industrial base undertaken by AFRL/Department of Commerce
- Working group generated consensus set of findings and recommendations

Principles

1. Space is critically important to U.S. national security
2. Global leadership in space is a national imperative
3. Similarly, sustaining technological superiority in space is a U.S. national interest
4. Given the interdependence between the defense, intelligence, civil and commercial sectors of space, U.S. leadership in all four is important [see chart, p.42]
5. A strong space industrial base is important
6. A prudent export control policy is necessary to control sensitive technologies
7. The U.S. must have unimpeded access to the technologies (global and domestic) needed for national security space systems

Executive Summary

The Health of the Space Industrial Base:

Finding 1: Overall financial health of the top tier manufacturers in the space industrial base is "good", but there are areas of concern within the broader health of the industry

Finding 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate

Finding 3: The U.S. space industrial base is largely dependent on the U.S. defense/ national security budget.

The implication is that the national security community "owns" the U.S. space (manufacturing) industry, and must either provide for the health of the industry ("arsenal strategy") or encourage it (and enable it) to participate more in the global market place to broaden its economic base

Executive Summary (continued)

The International Landscape and the Impact of Export Controls (1/3):

- The U.S. and its space industrial base is operating/competing in an increasingly globalized and interconnected environment

  Finding 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation.

  Finding 5: U.S. preeminence in space is under challenge in many areas.

  Finding 6: The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it (ITAR-free space products).

  The grand strategic intent of the space export controls is not being achieved

- In some cases, the space export control policy is running counter to the national space policy

  Finding 7: U.S. leadership in space benefits significantly from access to foreign innovation and human capital. That access is becoming increasingly difficult.

Executive Summary (continued)

The International Landscape and the Impact of Export Controls (2/3):

- In some cases, the space export control policy is running counter to the national space policy (continued)

  Finding 8: The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and is feeding a growing separation between the U.S. space community and an emerging non-U.S. space community.

  Finding 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy, which has as one of its goals to "encourage international cooperation with foreign nations on space activities that are of mutual benefit" and states that "space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably".

Executive Summary (continued)

The International Landscape and the Impact of Export Controls (3/3):

- U.S. industry is losing share in the international market and turning away from those markets, with the greatest burden being borne by the 2nd and 3rd tier of the industry

Finding 10: The U.S. share of the global space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign space markets.

Finding 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business, particularly the 2nd and 3rd tier.

And it is the 2nd/3rd tier of the industry that is the source of much innovation, and is normally the most engaged in the global market place in the aerospace/defense sector

- The goal is to bring space export control policy in line with the national space policy, achieve its strategic intent while not creating unintended negative consequences to industry

Finding 12: A U.S. export control policy that protects sensitive security space capabilities is important.

Finding 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security.

Executive Summary - Recommendations

1. The Administration and Congress should review and reconcile the strategic intent of space export controls. [Findings 6,7,8,9]
2. Critical space technologies should be identified and should remain on the Munitions List and under the State Department ITAR process. [Findings 4,5,9, 12]
3. Remove from the Munitions List commercial communications satellite systems, dedicated subsystems, and components specifically designed for commercial use; provide safeguards by having Defense Department identify critical space components and technologies that should always require licensing and referral. Have the appropriate executive branch departments conduct a study to see if other space technologies should be removed from the USML (e.g., weather satellites). [Findings 4,5,7,10, 11, 12, 13]
4. Annually review the appropriateness of designating specific satellite and other space systems, components, and capabilities as Munitions List items based on criticality of items and on their availability outside the U.S. [9,13]
5. Additionally, Congress could amend the legislation related to satellite export licensing and adopt some of the best practices being used in other processes – set timelines, technology thresholds, de minimus rules, and special licensing vehicles. [Findings 8, 9, 10, 11, 12, 13]
6. The Secretary of Defense and NASA Administrator, in addition to the Secretary of State, should have the authority to grant real-time, case-by-case, specific time period exemptions for anomaly resolutions deemed to be in the national interest based on criteria from the National Space Policy. [Findings 8,9]
7. Create a special program authority to permit timely engagement of U.S. participants in multinational space projects. [Findings 7,8,9]
8. Increase the dollar threshold for satellite exports Congressional notification and establish a mechanism to allow the threshold to adjust with inflation. [Findings 8, 10, 11, 13]
9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base. [Findings 1, 3]

Health of the Space Industrial Base

Findings 1: Overall financial health of the top tier manufacturers in the space industrial base is "good", but there are areas of concern within the broader health of the industry

Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate

Findings 3: The space industrial base is largely dependent on U.S. defense/ national security budgets

Findings 1: Overall financial health of the top tier manufacturers in the space industrial base is "good", but there are areas of concern within the broader health of the industry

- "For at least the last decade, the space industry has experienced high volatility, high risk, market bubbles and financial losses" Space Foundation White Paper, April 4, 2006
- There is currently a recovery under way in the space industry, particularly as the national security space sector undertakes the upgrading/replacement of virtually every type of capability in orbit
- The financial health of the space manufacturers has recovered, but margins remain thin and below the average for the general aerospace/defense industry – particularly the 2nd and 3rd tier [see chart of manufacturer's profits, p. 43]
  - AFRL survey shows average margins of primes has recovered from deep losses in 2003/2004 to reporting 2.5% net margins in 2006
  - …and average net margins of 5% at the 2nd/3rd tier
  - Note this stands in contrast to average net margins of 5% for primes and 6-8% for the 2nd/3rd tiers in the defense sector; let alone 9% in the high technology manufacturing sectors of the general economy

Findings 1: Overall health of the industrial base (Continued)

The areas of concern about the space industrial base include:

•Identified weaknesses in the 2nd and 3rd tier of the industry - e.g. where there is only one domestic supplier, financially weak supplier, etc.

Selected Areas of Concern in the Space Supplier Base

- Solar Cells
- Li-Ion Batteries
- Travelling Wave Tubes
- Visual Imagers
- Optical Coatings
- Read-out Integrated Circuits
- Infrared Focal Plane Arrays
- Solar Cell Substrates

Source: Aerospace Corp analysis, 2006

- Note: a healthy 2nd/3rd tier is important given the role it plays in generating innovation

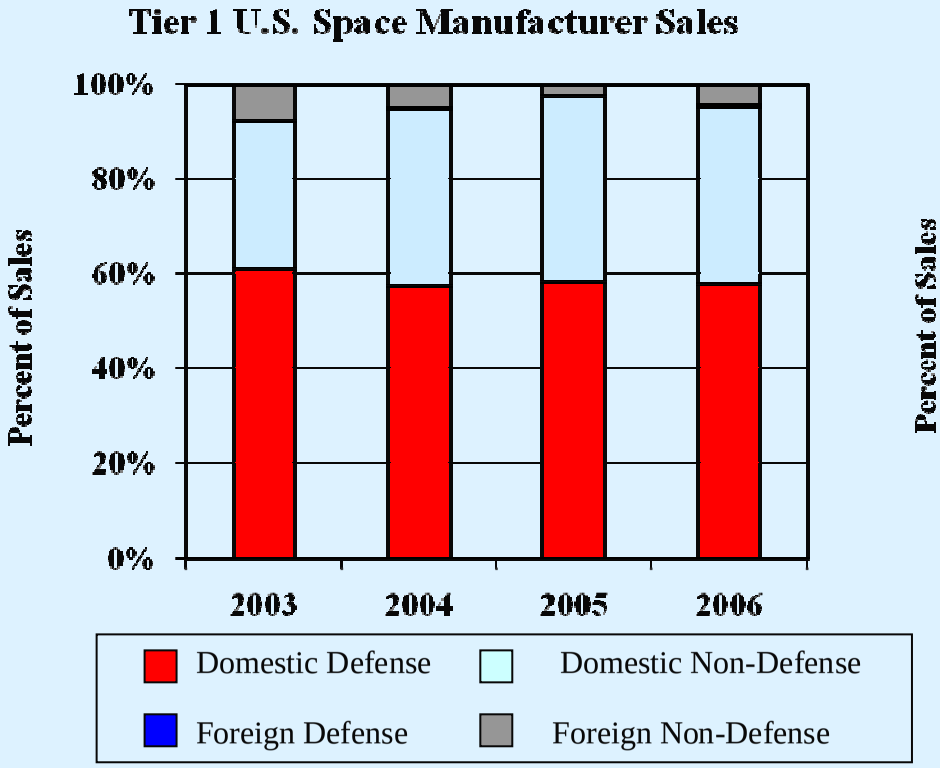
- …and well reported looming issues with the space-related workforce, particularly with the next generation [see chart from OSD report, p. 44]

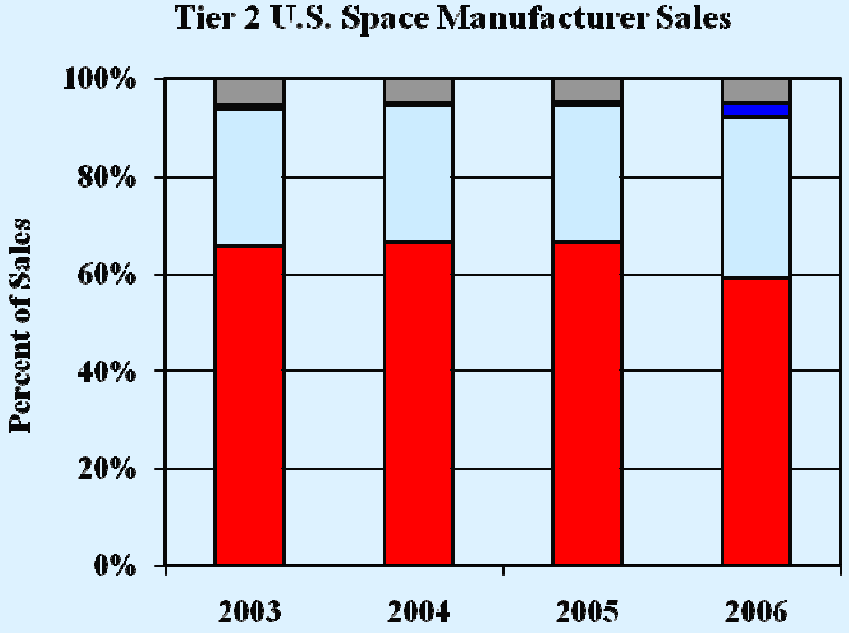
Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate

- The issue of program management and systems engineering skill shortages in government and industry have been well identified in numerous studies over the last five years [see detailed comments from reports, p. 45]
  - "Lack of specific objectives and milestones"
  - "Shortfalls in experience levels"
  - "critical skill shortages in program management, systems engineering, and software development", etc.

- The problem has been recognized, and there are initiatives in place to address this situation (but it is too early to determine effect). However, the desire to build complex, system-of-systems exacerbates the skills issue. Furthermore, it takes up to 10 years to "grow" systems engineers and multiple program experiences are critical (given the limited number of new starts participation in all space sectors or internationally is therefore important)

Findings 3: The space industrial base is largely dependent on U.S. defense/national security budgets





Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

- Percent of market dominated by U.S. defense/national security/government customers more akin to naval shipbuilding or tanks, than aerospace or other parts of aerospace/defense

Health of the U.S. Space Industrial Base

Implies that the national security community "owns" the U.S. space industrial base, and must either provide for the health of the industry ("arsenal strategy") or encourage it (and enable it) to participate more in the global market place to broaden its economic base

International Landscape and the Impact of Export Controls

- The Global Landscape
- National Space Policy and Export Control
- U.S. Industry, the International Markets and Export Control Policy
- Export Control Policy

The Global Landscape

Findings 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation

Findings 5: United States preeminence in space is under challenge in many areas

Findings 6: The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it.

Findings 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation
Findings 5: United States preeminence in space is under challenge in many areas

- Where the U.S. was once part of a very exclusive club, the number of nations active in space continues to grow
  - Triple the number of countries with their own positioning/navigation systems since 1999
  - Double the number of countries with their own reconnaissance/earth observation satellites since 1999
  - A dozen countries able to launch their own satellites
  - 38 countries with operational control over their own communication satellites

[See detailed chart for more info, p. 46]

- Furthermore, the sophistication of overseas and commercial capabilities continues to increase
  - Example: Russia, France, Israel, Korea and India all possess commercial imaging satellites of one meter resolution or better
  - Example: Canada, European Space Agency, Italy, Germany and Japan possess civil radar imaging satellites; soon India and Argentina will join the list; China has launched two military radar imaging satellites

Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence in space is under challenge (continued)

- In the global commercial communications satellite market, where the U.S. had a technical and qualitative lead over the international competition in the 1990s, that competition has significantly closed the gap in the last decade
  - Since 1998, European and Asian manufacturers of satellites have gone from delivering satellites that were smaller, had fewer transponders, lesser payload power and shorter lives to manufacturing satellites of equal weight, number of transponders, payload power and lifespan

[see detailed table comparing U.S., European and Asian satellite capabilities , p. 47]

- As much as the U.S. would like to control this spreading of capabilities, international activity continues
  - Sino-Russian cooperation
  - Russian-European cooperation
  - Russian-Indian discussions

Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence in space is under challenge (continued)

- Other space faring nations continue to make strides, whether they have access to U.S. technology or not [see detailed chart of Chinese and Indian space milestones, p. 48]
- Since 1999 China has:
  - Launched an indigenous navigation system
  - Launched first 3m satellite
  - Conducted its first manned spaceflight
  - Tested an ant-satellite missile
  - Sold the first Chinese built satellite to a foreign buyer (Nigeria)
  - Launched first lunar probe

Findings 6: The current export control policy has not prevented the rise of foreign space capabilities and in some cases has encouraged it.

- For years, China has chafed at efforts by the United States to exclude it from full membership in the world's elite space club. So lately **China seems to have hit on a solution: create a new club**. (NY Times, May 23, 2007)
- "It's a shame, but it's not for me to comment on U.S. law, only to note its effects, and for the Rover, ITAR would have made cooperation too complicated to be feasible. … **We are now obliged to develop our autonomy in various areas, which is no bad thing** … We may also find partners besides NASA" – Daniel Sacotte, head of ESA's Human Spaceflight program (May 30, 2005)
- "It is a matter of particular pride that **international technology denial regimes have not impeded your efforts — in fact, they have spurred you to greater heights**", Indian Prime Minister to ISRO (Indian Space Research Organization), September 21, 2005
- Other examples include:
  - European Space Agency spending funds to develop a European supplier of solenoid valves, in order to remove that U.S. part from European space propulsion systems
  - CASA of Spain, which had limited capability as supplier of reflectors, funded to develop reflectors by non-U.S. satellite primes as part of ITAR-free movement. Now a global competitor in reflectors.

The grand strategic intent of the space export controls is not being achieved

National Space Policy and Export Controls

Findings 7: U.S. leadership in space benefits significantly from access to foreign innovation and human capital, but access is becoming increasingly difficult

Findings 8: The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and is feeding a growing separation between the U.S. space establishment and an emerging non-U.S. space establishment.

Findings 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy

Findings 7: U.S. leadership in space benefits significantly from access to foreign innovation and human capital, but access is becoming increasingly difficult

- The U.S. has historically employed a successful model of being a "vacuum cleaner" of the world's best innovation, technology and human capital; and then turning this raw technology into value-added space and defense systems
  - U.S. has been leveraging foreign innovation/human capital in space for 60 years
    - From Werner von Braun to use of the Russian RD-180 engines on the U.S. Atlas IIIA
    - "The key to maintaining U.S. technological preeminence is to encourage open and collaborative basic research. **The linkage between the free exchange of ideas and scientific innovation, prosperity, and national security is undeniable**"
      - National Security Advisor Rice (2001)
    - Given that foreign students earn more than half of the science, technology and engineering PhD's and foreign-born workers make up more than a quarter of the U.S. ST&E workforce – the inability to access this group automatically shrinks the available talent pool
  - Furthermore the total applications of foreign graduate students to U.S. universities was down 19% in 2004-2007

Findings 8: The current export control policy is constricting U.S. engagement and partnership with the rest of the global space community, and fed a growing separation between the U.S. and an emerging non-U.S. space community.

• **"Collaboration between U.S. and European scientists is harder now** than it was before U.S. technology-transfer rules were tightened in 1999 … U.S. government officials charged with reviewing bilateral or multilateral science projects have been so worried about being accused of letting sensitive technologies slip into the wrong hands that they have overcompensated" – Nobel laureate George F. Smoot (*Space News*, February 8, 2007)

• "[Export Control rules cause] problems between us and our international partners that are **really more of a problem than the benefit** we are gaining by having the ... restrictions in there," – William Gerstenmaier, NASA's associate administrator for space operations (*Space News* May 21, 2007)

• "[A] contractor workforce comprises the majority of the [International Space Stations] operations workforce and must be able to have a direct interface with the IP operations team to assure safe and successful operations. Their interactions and their ability to exchange and discuss technical data relevant to vehicle operations or severely hampered by the current ITAR restrictions."…"**Currently the ITAR restrictions and the IPs' objections to signing technical assistance agreements are a threat to the safe and successful integration and operations of the Station.**" – Tommy Holloway, Chair, International Space Station (ISS) Independent Safety Task Force (House S&T Committee, 7/24/2007)

Findings 8: The current export control policy is constricting U.S. engagement and partnership (Continued)

- One specific area where export controls are constraining U.S. engagement related to Technical Assistance Agreements. TAA's which are critical for partnerships and marketing are taking longer to approve, from average of 52 days in 2003 to 106 days in 2006 (in competitive situations, 60 days response time to RFP's is not unusual)

[see table for detailed data, p.49]

- Another area of concern regarding U.S. international engagement and partnership is the ability to conduct anomaly resolution

Findings 9: Some elements of the export controls laws are in conflict with U.S. National Space Policy

- One of the goals of the National Space Policy is to "encourage international cooperation with foreign nations on space activities that are of mutual benefit"; it also states that "space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably".

Among the unintended consequences:

- The munitions list is not consistent with the current assessment of which space technologies that should be controlled
- The U.S. space export control regime does not match its goals of both enabling cooperation with allies and denial of capabilities to opponents. The current regime does not provide policy makers with the nuance or flexibility needed to serve the National Space Policy
- Satellites and their components were placed on the U.S. Munitions List due to Congressional action with the intent of limiting the spread of space technology. However, this has had the unintended consequence of encouraging the proliferation of space capabilities, has not prevented the rise of other space powers but has impacted U.S. competitiveness.
- There has been an adverse industrial and technological impact to the U.S. ITAR implementation introduces a friction for U.S. companies competing in the global market, as much as $600 million a year, which in turn feeds space development that the U.S. is not involved in
- The continuation of our legacy of beneficial collaboration with foreigners has been impeded, as has our ability to do anomaly

Corresponding section in US National Space Policy:

- "As a [effective export policy] guideline, space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably"
- "Develop and deploy space capabilities that sustain U.S. advantage and support defense and intelligence transformation; … Develop capabilities, plans, and options to ensure freedom of action in space, and, if directed, deny such freedom of action to adversaries"
- "Refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities, unless required by national security or public safety"
- "A robust science, technology, and industrial base is critical for U.S. space capabilities… Use U.S. commercial space capabilities and services to the maximum practical extent"
- "Encourage international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foreign policy objectives"

U.S. Industry, the International Markets and Export Control Policy

Findings 10: The U.S. share of the foreign space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign markets

Findings 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business, particularly the 2nd and 3rd tier.

Findings 10: The U.S. share of the foreign space markets is steadily declining, and U.S. companies are finding it increasingly difficult to participate in foreign markets

- Study after study shows the same results, an erosion of U.S. share of the global commercial satellite market since the late 1990s [see detailed charts for examples, p. 50-52]
  - FAA, Institute for Defense Analyses, Satellite Industries Association, NASIC

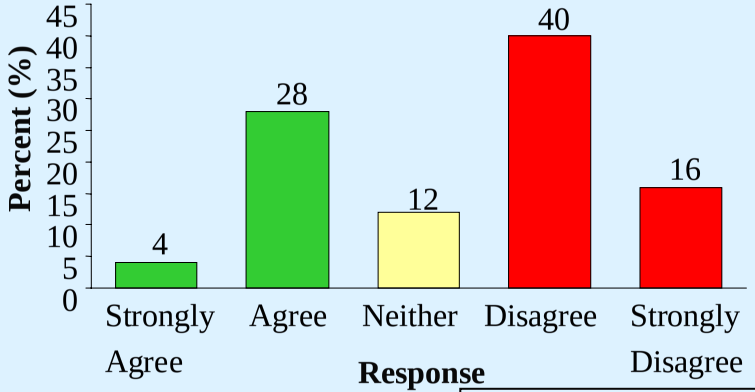
- "One European aerospace executive said export customers were asking for systems which were 'ITAR free.'" Defense News (June 19, 2007)
- "We will not buy from U.S. due to export controls." Canadian TELESAT
- Other examples where U.S. components and technology are being designed out include:

- **Creation of ITAR-free European apogee motor**
- **ITAR-free European thruster control valves**
- **ITAR-free European star tracker**
- **Microwave components from the Astrium Megha-Tropiques mission instruments**
- **Alcatel satellite bus**
- **zGRACE mission where U.S. systems integrator was replaced by a foreign contractor**

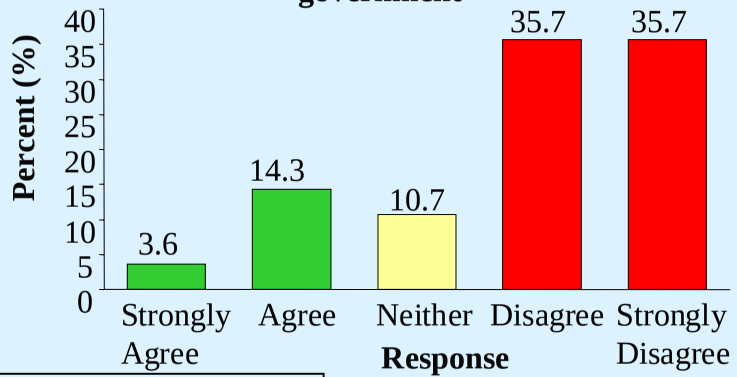
Findings 10: …and U.S. companies are finding it increasingly difficult to participate in foreign markets (cont'd)

- US companies frustrated by uncertainty that ITAR involves

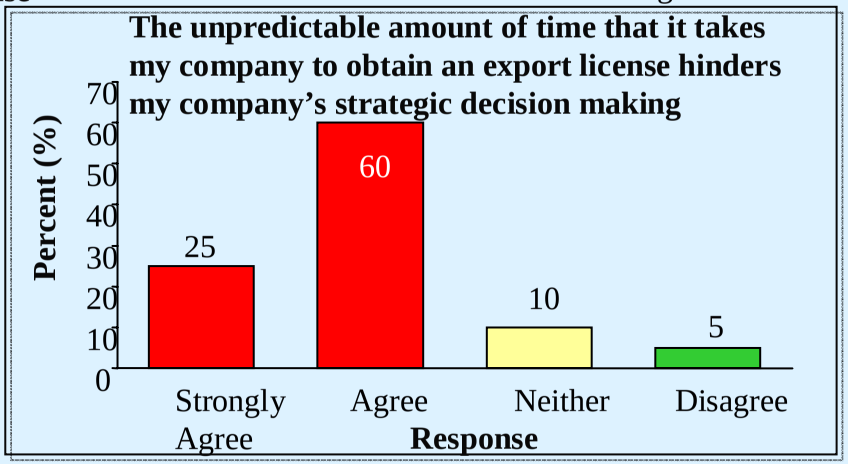
It is easy to understand ITAR licensing requirements for a defense article or service



I can predict with confidence the amount of time it takes for my company to obtain an export license from my government



The unpredictable amount of time that it takes my company to obtain an export license hinders my company's strategic decision making

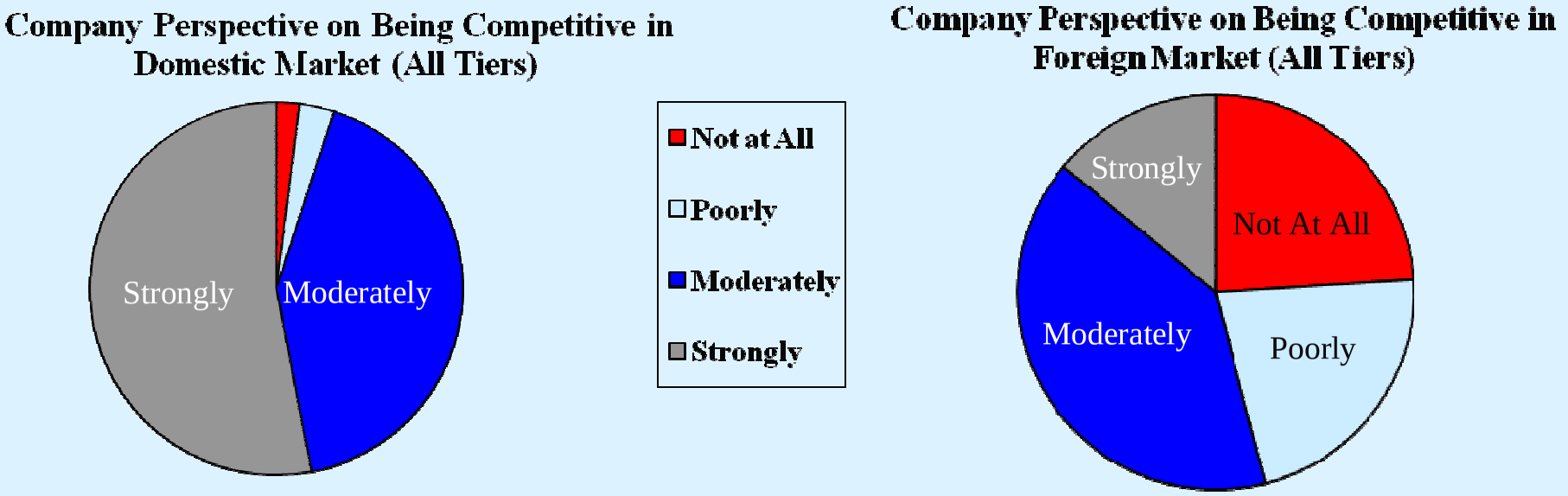


Source: Booz Allen survey of U.S. industry executives, May 2006

Findings 10: …and U.S. companies are finding it increasingly difficult to participate in foreign markets (cont'd)

- So much so, that it impacts the space industry's confidence in being able to compete in foreign markets

Will your company be well positioned to compete in the (domestic/foreign) markets in the 2008-2012 period?



Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

Findings 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business - particularly the 2nd and 3rd tier.

- U.S. is the only country that classifies commercial communications satellites as a "munition"
- U.S. export controls are cited as the #1 barrier to foreign markets by industry [see detailed chart, p. 53]
- An average $600 million per year of lost revenues due to licensing issues has been cited by industry (Caveat 1: there may be double counting between industry competitors; Caveat 2: the data does not include competitions that were not pursued by US industry due to ITAR) [see detailed table, p. 54]
- The burden on the 2nd and 3rd tier of the industry is particularly heavy
  - Compliance costs averaged $50M per year for the industry [see detailed chart, p. 55]
  - Costs have increased 28% since 2003
  - As a percent of foreign sales, the cost burden on Tier 3 companies is nearly 8 times that of Tier 1 firms (Less resources = less investment)

Total costs of compliance divided by foreign sales

	Total Export Control Burden			
	2003	2004	2005	2006
Tier 1	0.9%	0.9%	1.5%	1.1%
Tier 2	2.0%	2.1%	3.1%	1.9%
Tier 3	8.0%	7.6%	6.2%	7.7%

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

Findings 11: Export controls are adversely affecting U.S. companies' ability to compete (Continued)

- Once commercial satellites were placed on the Munitions List, given the structure of the ITAR (any component on a munitions list item is a munition), the 2nd and 3rd tier of the industry were impacted… intended or not

> "**We never wanted to control parts and components.**"
>
> Former Director, Space Monitoring Division of DoD Defense Threat Reduction Agency, speech at Satellite 2007 conference (reported by The Space Review, February 26, 2007)

Export Control Policy

Findings 12: A U.S. export control policy that protects sensitive security space capabilities is important.

Findings 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security.

Findings 12: A U.S. export control policy that protects sensitive security space capabilities is important.

> "Exports of **sensitive or advanced** technical data, systems, technologies, and components, shall be approved only rarely, on a case-by-case basis. These items include systems engineering and systems integration capabilities and techniques or enabling components or technologies **with capabilities significantly better** than those achievable by current or near-term foreign systems."
>
> – National Space Policy (2006)

Findings 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security.

- The Departments of State, Defense and Commerce are all undertaking reform exercises to reduce processing times and streamline the export control licensing process
- There are numerous broad export control reform efforts under way

President Bush's Technology Agenda:

"The current high tech export control system is awkwardly structured, hindering U.S. businesses, while failing to strengthen our national security."

Coalition for Security and Competitiveness: Recommendations for Modernizing Export Controls on Munitions List Items (2007):

"[T]he U.S. export control system must be modernized so that it is better able to respond quickly and effectively to evolving security threats, and promote our nation's continued economic and technological leadership." (p. 1)
***Recommendations*: Provide more resources and high level attention while streamlining the process.**

Studies by National Academies of Sciences, Defense Science Board, NATO Industrial Advisory Group, Hudson Institute, Heritage Foundation, CSIS and others

Findings 13: There is unanimous agreement that the export control process can be improved without adversely affecting national security (continued)

- State Department International Security Advisory Board – Report on Space Policy, April 25, 2007

From the State Department International Security Advisor Board Report:

"The Department of State should be prepared to **facilitate international cooperation in the use of space through U.S. export policies.** The Department of State, therefore, in its regulation of satellite exports, should focus on ways to **streamline the licensing process**. While it is obviously essential to protect U.S. national security and space control, the current process damages U.S. cooperation with friends and allies and weakens the U.S. commercial space satellite industry and the underlying industrial base that develops civil, commercial, military, and intelligence space assets.

The **current International Traffic in Arms Regulations (ITAR) list is too broad.** It includes too much technology that is widely available internationally. Moreover, a single international transaction involving commercial space technology now often requires multiple licenses. Licenses often come with extensive restrictions that make resubmission necessary, causing further **delay and uncertainty** for U.S. manufacturers in the commercial international market place.

State ISAB Recommendation #10: The State Department should review the technology in the International Traffic in Arms Regulations (ITAR) list with a view toward regulating key technologies and exporters. The State Department needs to move toward issuing licenses that are sufficiently broad to enable the process to move forward more quickly. "

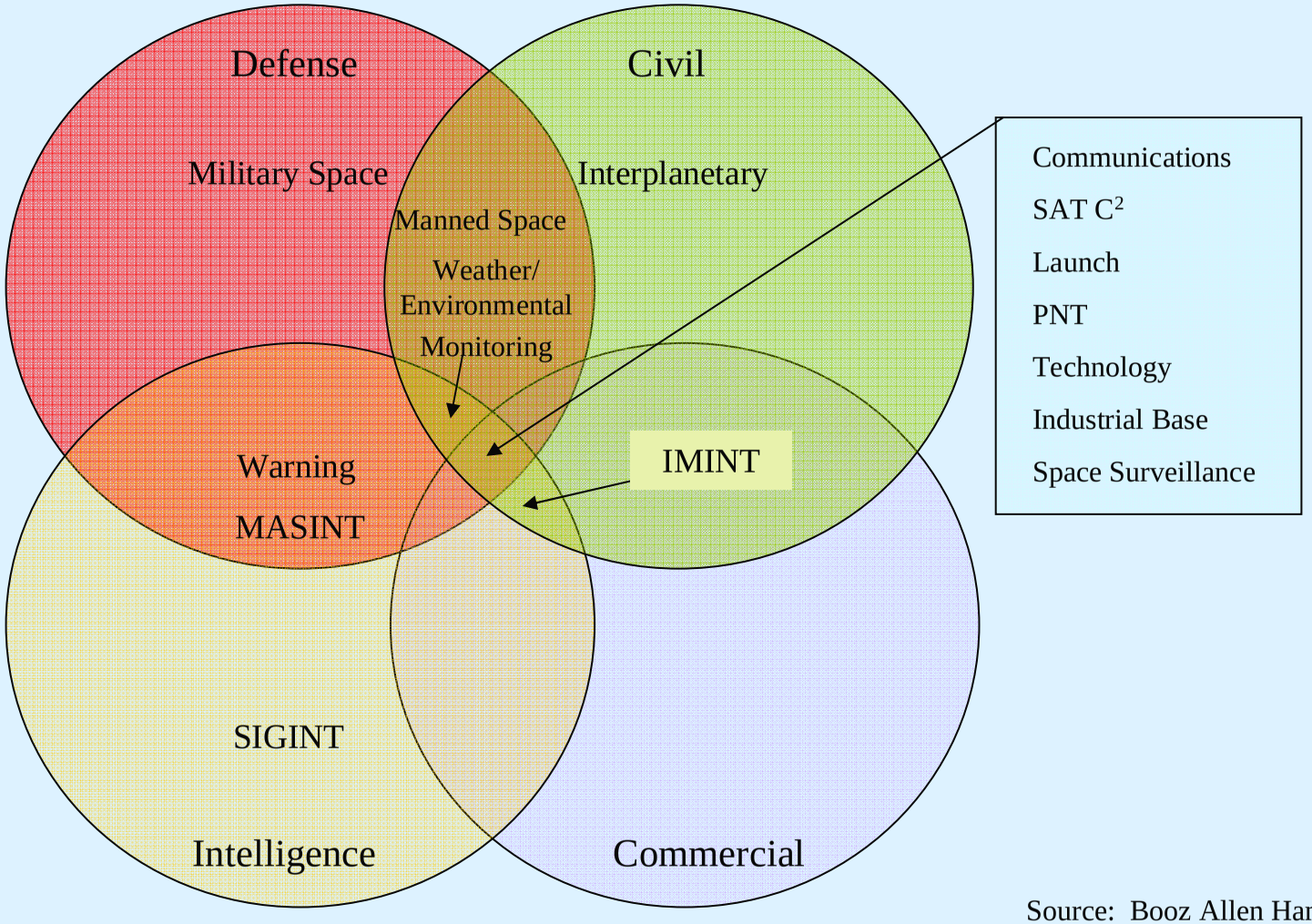
Recommendations

Recommendations

1. The Administration and Congress should review and reconcile the strategic intent of space export controls.
2. Critical space technologies should be identified and should remain on the Munitions List and under the State Department ITAR process.
3. Remove from the Munitions List commercial communications satellite systems, dedicated subsystems, and components specifically designed for commercial use; provide safeguards by having Defense Department identify critical space components and technologies that should always require licensing and referral. Have the appropriate executive branch departments conduct a study to see if other space technologies should be removed from the USML (e.g., weather satellites).
4. Annually review the appropriateness of designating specific satellite and other space systems, components, and capabilities as Munitions List items based on criticality of items and on their availability outside the U.S.
5. Additionally, Congress could amend the legislation related to satellite export licensing and adopt some of the best practices being used in other processes – set timelines, technology thresholds, de minimus rules, and special licensing vehicles.
6. The Secretary of Defense and NASA Administrator, in addition to the Secretary of State, should have the authority to grant real-time, case-by-case, specific time period exemptions for anomaly resolutions deemed to be in the national interest based on criteria from the National Space Policy.
7. Create a special program authority to permit timely engagement of U.S. participants in multinational space projects.
8. Increase the dollar threshold for satellite exports Congressional notification and establish a mechanism to allow the threshold to adjust with inflation.
9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base.

Detailed Data Backup

Principles – Space Sector Interdependence



Source: Booz Allen Hamilton

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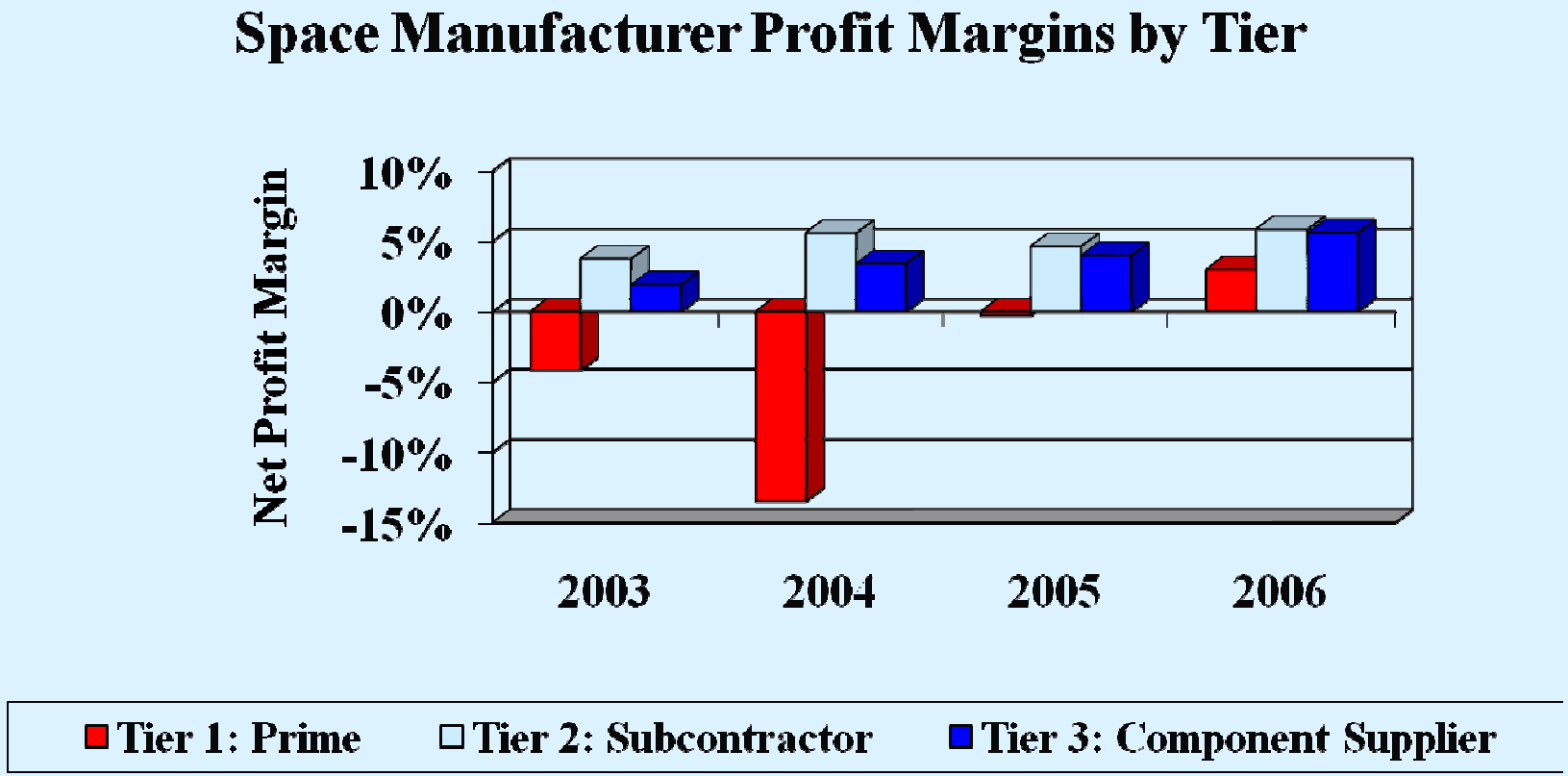
Data for Findings 1: Overall financial health…



Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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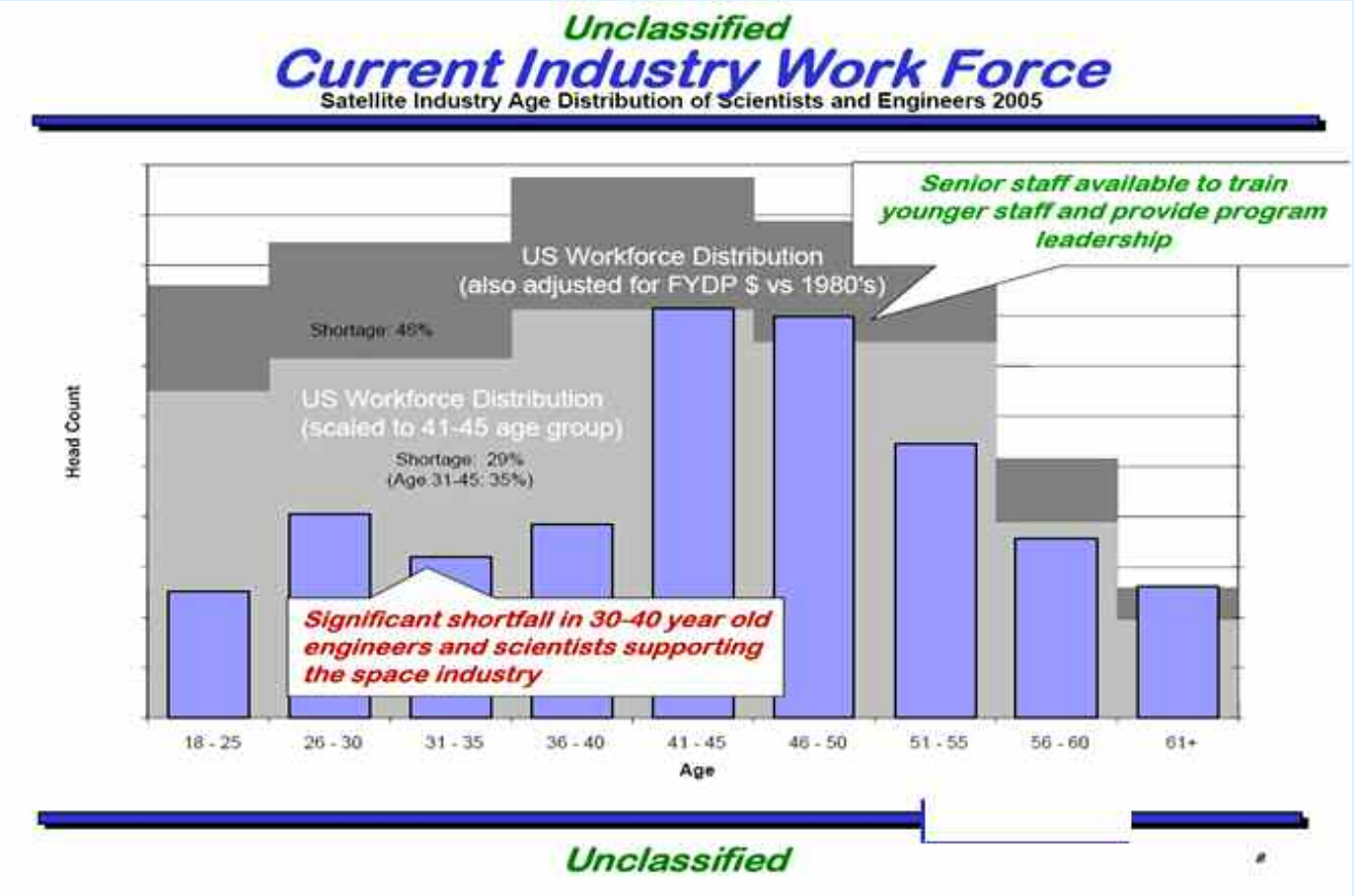
Data for Findings 1: Overall financial health… (Continued)

- There continue to be looming issues with the space-related workforce, particularly with the next generation



Source: OSD report, 2006

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Data for Findings 2: As earlier studies have documented, the ability of the government and industry to meet program execution commitments remains inadequate

- Commentary from various studies:

  - "DOD has not established specific space objectives that are linked to overall program goals and resource requirements, nor has it established specific performance goals or other mechanisms to measure program outcomes…the services do not have clearly defined space objectives and milestones to guide their initiatives, nor does DOD have a mechanism to ensure successful accomplishment of integrated efforts without gaps and duplications" (GAO, *Defense Space Activities: … Further Management Actions Needed,* 2003, pp. 19-20).
  - "The authority of program managers and other working-level acquisition officials subsequently eroded to the point where it reduced their ability to succeed on development programs … Widespread shortfalls exist in the experience level of government acquisition managers, with too many inexperienced personnel and too few seasoned professionals … The lack of dedicated career field management for space and acquisition personnel has exacerbated this situation" (DSB, *Acquisition of National Security Space Programs*, 2003, p. 3).
  - "DOD's major weapon system program managers and program executive officers … pointed to critical skill shortages in program management, systems engineering, and software development" (p.1). "The majority of major acquisition programs in DOD's space portfolio have experienced problems during the past two decades that have driven up cost and schedules and increased technical risks." (p. 7). (GAO, *Space Acquisition: Actions Needed to Expand and Sustain Use of Best Practices,* 2007).

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Data for Findings 4: There are rapidly emerging foreign space capabilities and the U.S. does not control their proliferation

Findings 5: United States preeminence in space is under challenge in many areas

# of countries / Time period	Launch own satellites	Launched human spaceflight	Own positioning/ navigation system	Launched own recon / earth observation sat.	Control over own COMSAT
1980	10	2	2	3	17
1999	12 (+Ukraine, Brazil)	2	2	14	32
2007-8	12	3 (+China)	6(+China, India, EU, Japan)	27	38
2010-2025	Steady growth	India, ESA and Japan active	Full operationalization of EU, Asian systems	Steady growth	Steady growth

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Data for Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence under challenge (cont'd)

Comparison of Satellite Capabilities (1990s vs 2000s)

1996-1998 / 2004-2007	Hughes / Boeing	Lockheed-Martin	Loral	Aerospatiale / Alcatel Alenia	Matra Marconi / EADS Astrium	Chinese (CASC)	Mitsubishi Elec. Corp
Bus	HS-601 / Boeing 702	A2100 / A2100AX	LS-1300 / LS-1300	Spacebus 2000 / Spacebus 4000	Eurostar 2000+ / Eurostar 3000	DFH-3 / DFH-4	No comm sats built. / DS-2000
Select or Representative Spacecraft	ASTRA-1G / Anik F2	AMC-1 / AMC-11	Intelsat 709 / SATMEX 6	AMC-5 / KoreaSat 5	ST-1 / Anik F-1	Chinasat 6 / NigComSat 1	/ Superbird 7
Launched	1997 / 2004	1996 / 2004	1996 / 2006	1998 / 2006	1998 / 2005	1997 / 2007	-- / planned 2008
In-orbit reliability/failure	25 built before first malfunction in 1998 / 75% of buses had insurance claim	Named by Frost & Sullivan as "most reliable" for most apps.			86% platform reliability after 10 years.	2 satellites reported as malfunctioning (1 lost as a result); / Solar panel failure took out first	
# of transponders	32 / 102	24 / 48	36 / 60	16 / 36 (up to 110)	30 / 84	24 / 28	0 / 28
Life span (years)	15 / <10	15 / 15	15 / 15	10 / 15	15 / 15	8 / 15	0 / 15
Payload power (BOL kW)	6.6-8 / 16	7 / 6.5	3.9 / 14	-- / 9-16	6.5-7 / 16	4 / 7-10	
Weight (BOL lbs)	5,467 / 8,390	3,520 / 5,095	4,850 / 5,082	1,692	3,300 / 6,490	2,320-2,740 / 5,000	
Total production by 2006	72 / 16	21 / 16	66 (all models)	12 / 7	7 / 10	5 / 3	

Source: CSIS

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Data for Findings 4 & 5: Rapidly emerging foreign space capabilities and U.S. preeminence under challenge (cont'd)

Indian Space Milestones

- 1962: Space program started by Vikram Sarabhai
- 1975: First satellite launch ("Aryabhata")
- 1979: First (experimental) earth observation satellite ("Bhaskara-1")
- 1980: First indigenous satellite launch ("Rohini-1")
- 1984: First manned space mission (part of Soviet mission)
- 1997: First satellite launched using indigenous polar satellite launch vehicle
- 1999: Satellites returned to U.S. Munitions List
- 2001: First "high resolution" (~1m) imaging satellite
- 2004: Partners with Russia on GLONASS navigation system
- 2007: Initial operational capability of indigenous GAGAN navigation system
- 2007: First launch and retrieve of (unmanned) spacecraft

Chinese Space Milestones

- 1956: Space program started by Qian Xuesen
- 1970: First satellite launch ("The East Is Red")
- 1971: First (store and forward) communications satellite
- 1973: Manned spaceflight program started
- 1975: First successful recon satellite launch
- 1990: "Biosat" containing 60 animals and plants
- 1990: First commercial satellite launch (Asiasat-1)
- 1999: Satellites returned to U.S. Munitions List
- 1999: First launch and retrieve of (unmanned) spacecraft (Shenzhou-1)
- 2000: Initial operational capability of indigenous Beidou navigation system
- 2000: First "high resolution" (~3m) imaging satellite
- 2003: First manned spaceflight (Shenzhou-5)
- 2005: Two astronauts in orbit perform experiments (Shenzhou -6)
- 2007: Anti-satellite missile launch
- 2007: First Chinese built satellite for a foreign buyer (COMSAT for Nigeria)
- 2007: First lunar probe launched

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Source: CSIS

Data for Findings 8: The current export control policy is constricting U.S. engagement and partnership

	TAA Submitted	TAA Approved	% Approved	TAA avg. time (days)
2003	508	439	86%	52
2004	610	565	93%	59
2005	829	722	87%	85
2006	698	627	90%	106

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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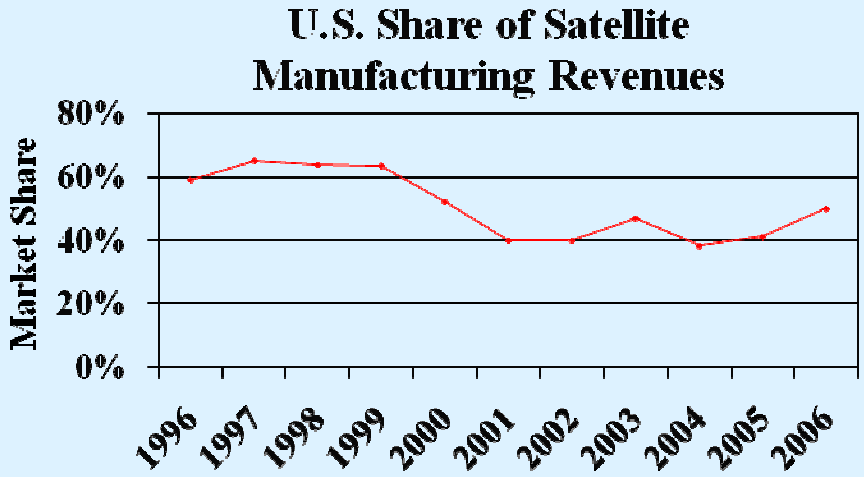
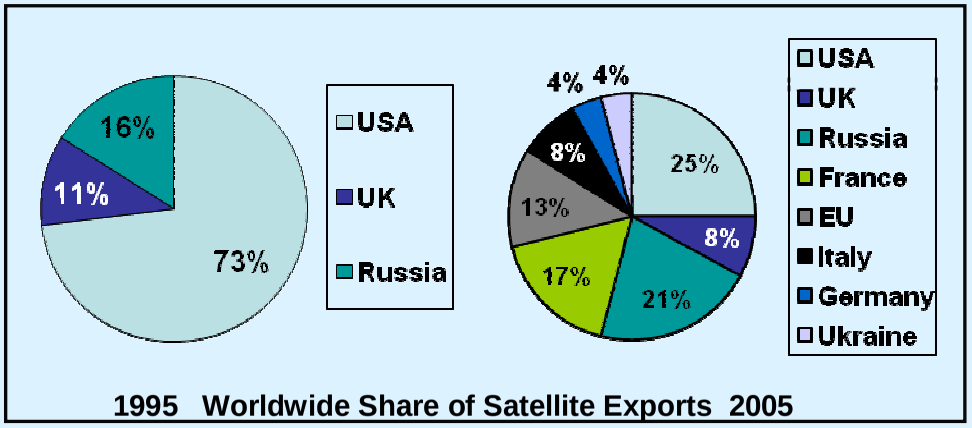
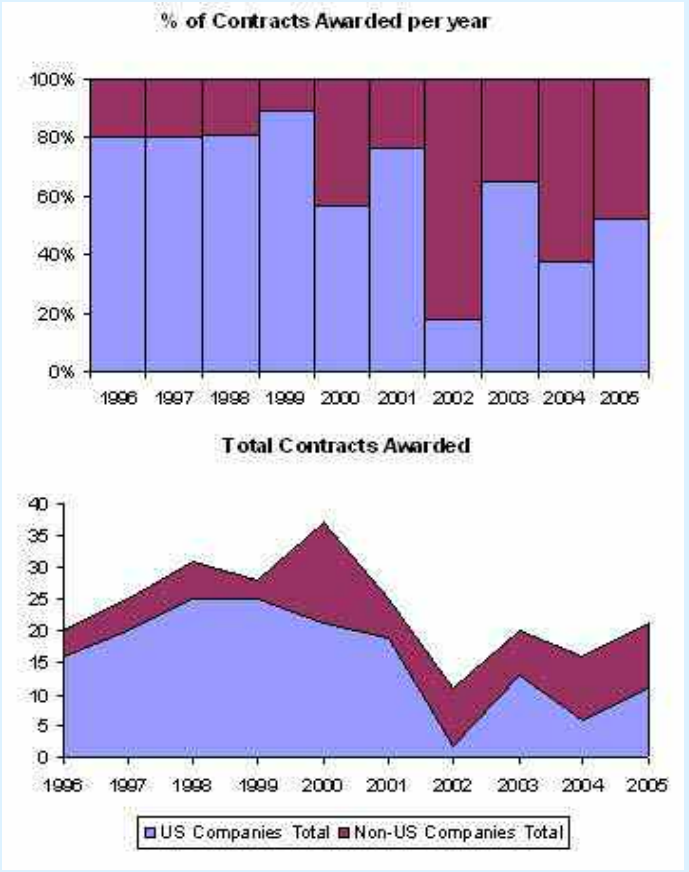
Data for Findings 10: The U.S. share of the foreign space markets is steadily declining



Source: Satellite Industry Association



Commercial Comsat Manufacturing Share



Source: NASIC

Source:

Data for Findings 10: The U.S. share of the foreign space markets is steadily declining (Continued)

Major Commercial GEO Satellite Programs

	Program	Customer Country	1990 - 1999	2000-2008
Switch Post ITAR	Apstar	Hong Kong	B B B S	S A
	Intelsat	International	B B B B L S S S S S S S S S L L L L L L	S S S S S S S E L
	SES Astra	Luxembourg	L B B B B B B B	B E B A B L L
	Telesat Canada	Canada	L L L	B L B E E
Switch Pre ITAR	Chinasat	China	B C	C
	Inmarsat	Inernational	E E E E L L L L L	E E E
	JCSat	Japan	J B B B	B L
	Panamsat	USA	B B B B B B B B U B B B B B B B S S B	B B B O O A L
	SES Americom	USA (Now Luxembourg)	L L L E L	L L L L A L L L L A A L
Captive US Market	Asiasat	Hong Kong	B L B B	B S
	BSAT	Japan	B B	O O O
	DirecTV	USA	B S B	B S S S S
	Echostar	USA	L L L L S	S L S L
	Loral Skynet	USA	L L L S S S S	S S S
	New Skies Satellites	Netherlands		L L B O B
	XM	USA		B B B B
Captive Foreign Market	Arabsat	Middle East	A A A A	E E
	Eutelsat	Europe	A A A A A A E E A E E E	A E A A A A E T A
	Express	Russia	N N	N N N N N N N N
	Insat	India	I I I	I I I I I

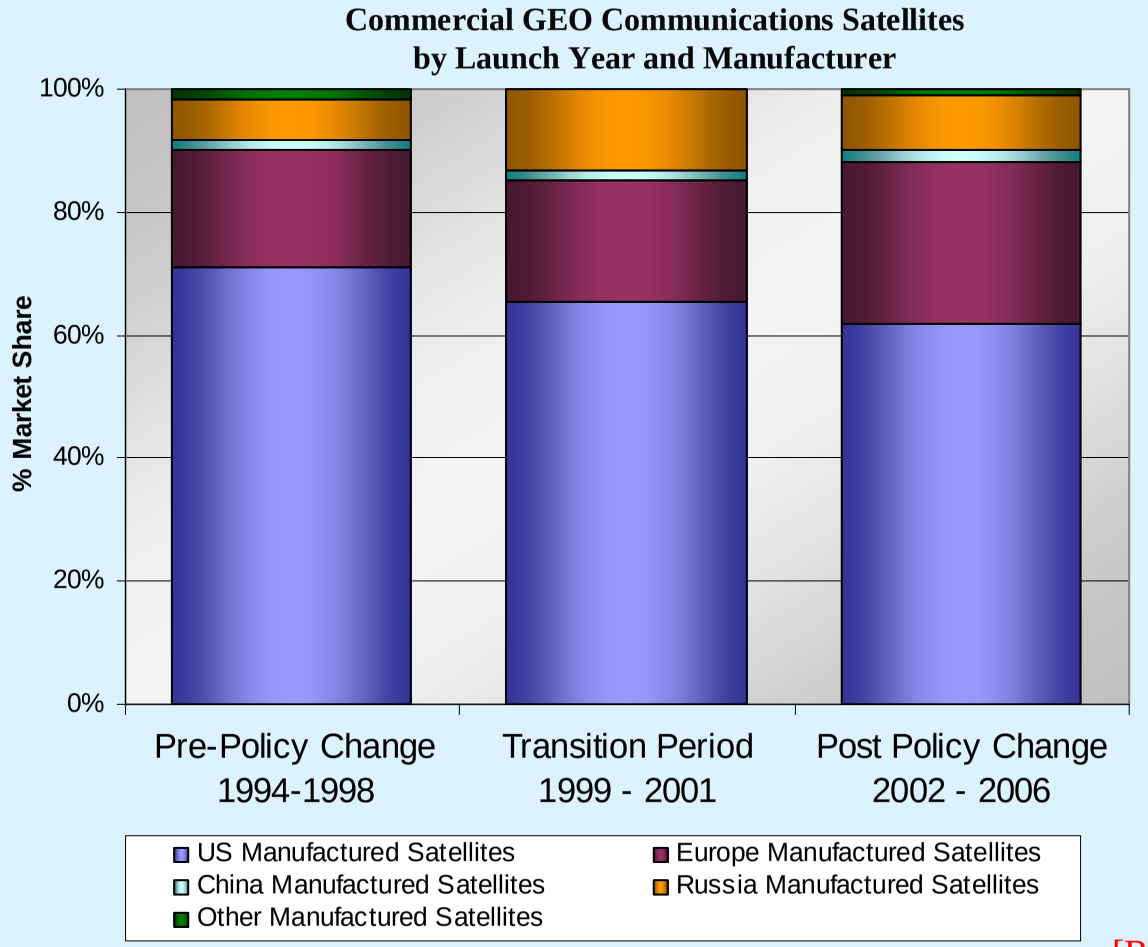
A:	Alcatel
B:	Boeing
E:	EADS
I:	ISRO
J:	JSAT
L:	Lockheed
N:	NPO PM
O:	Orbital
S:	Space Systems Loral
U:	ASC Contel (UK)
T:	Telespazio

US WIN

ROW Win

Source: Institute for Defense Analyses

Data for Findings 10: The U.S. share of the foreign space markets is steadily declining (Continued)



Source: FAA Office of Commercial Space Transportation Database

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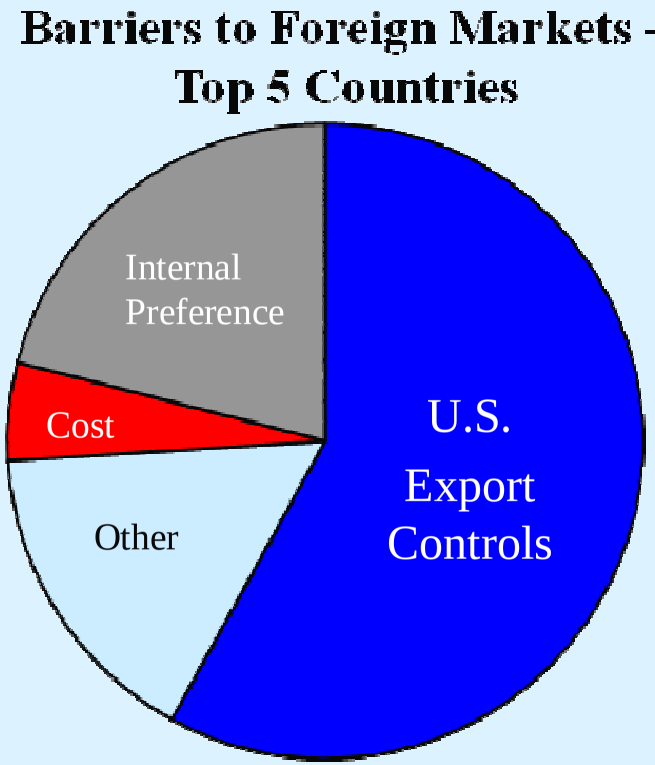
Data for Findings 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business -particularly the 2nd and 3rd tier.

- U.S. export controls are cited as the #1 barrier to foreign markets by industry



Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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Data for Findings 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business -particularly the 2nd and 3rd tier.

- An average $600 million per year of lost revenues due to licensing issues has been cited by industry (Caveat 1: there may be double counting between industry competitors; Caveat 2: this figure does not include competitions that were not pursued by US industry due to ITAR)

	Total Sales Subject to Licensing ($Millions)		Lost Sales Attributed to Licensing ($Millions)		Lost Sales as a % of Opportunities (Total Sales + Lost Sales)	
	ITAR	EAR	ITAR	EAR	ITAR	EAR
2003	$1,569	$64	$712	$0	31.2%	0.0%
2004	2,342	19	502	0	17.6%	0.0%
2005	6,166	118	628	0.4	9.2%	0.3%
2006	3,226	8	511	0.25	13.7%	3.0%

Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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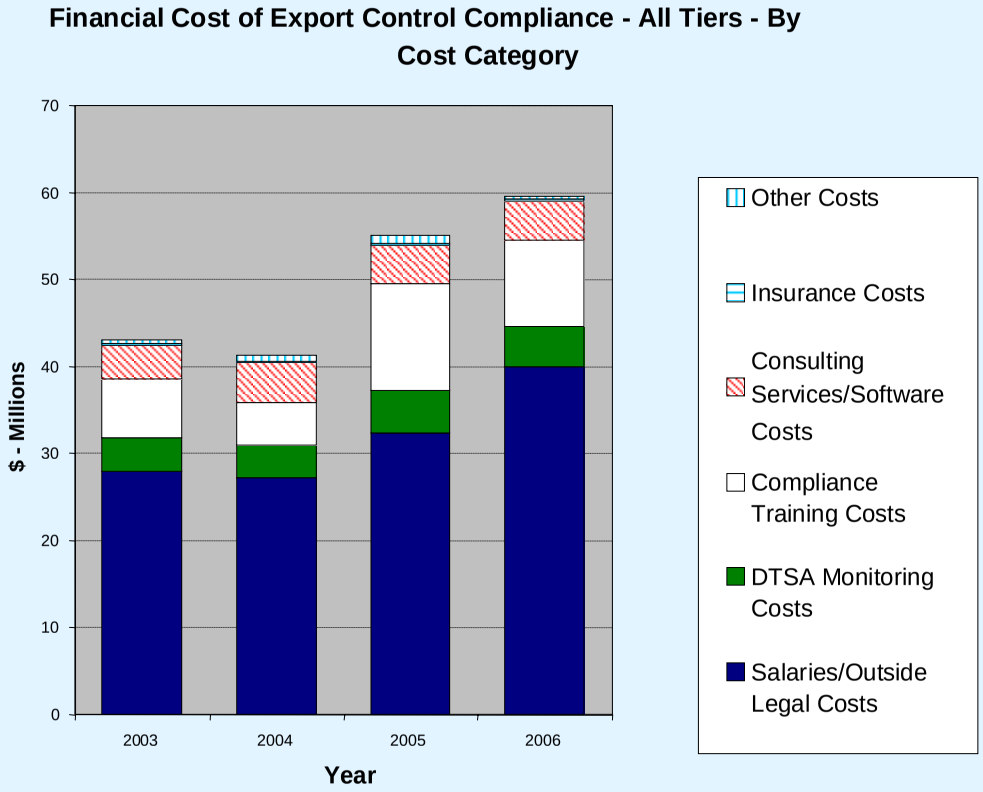
Data for Findings 11: Export controls are adversely affecting U.S. companies' ability to compete for foreign space business -particularly the 2nd and 3rd tier.

- The burden on the 2nd and 3rd tier of the industry is particularly heavy



Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

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Appendix

Strom Thurmond National Defense Authorization Act for Fiscal Year 1999

Title XV, Subtitle B – Satellite Export Controls

SEC. 1511. SENSE OF CONGRESS.

It is the sense of Congress that--

(1) United States business interests must not be placed above United States national security interests;

(2) United States foreign policy and the policies of the United States regarding commercial relations with other countries should affirm the importance of observing and adhering to the Missile Technology Control Regime (MTCR);

(3) the United States should encourage universal observance of the Guidelines to the Missile Technology Control Regime;

(4) the exportation or transfer of advanced communication satellites and related technologies from United States sources to foreign recipients should not increase the risks to the national security of the United States;

(5) due to the military sensitivity of the technologies involved, it is in the national security interests of the United States that United States satellites and related items be subject to the same export controls that apply under United States law and practices to munitions;

(6) the United States should not issue any blanket waiver of the suspensions contained in section 902 of the Foreign Relations Authorization Act, Fiscal Years 1990 and 1991 (Public Law 101-246), regarding the export of satellites of United States origin intended for launch from a launch vehicle owned by the People's Republic of China;

(7) the United States should pursue policies that protect and enhance the United States space launch industry; and

(8) the United States should not export to the People's Republic of China missile equipment or technology that would improve the missile or space launch capabilities of the People's Republic of China.

Strom Thurmond National Defense Authorization Act for Fiscal Year 1999

Title XV, Subtitle B – Satellite Export Controls (Continued)

SEC. 1513. SATELLITE CONTROLS UNDER THE UNITED STATES MUNITIONS LIST.

(a) Control of Satellites on the United States Munitions List.--Notwithstanding any other provision of law, all satellites and related items that are on the Commerce Control List of dual-use items in the Export Administration Regulations (15 C.F.R. Part 730 et seq.) on the date of the enactment of this Act shall be transferred to the United States Munitions List and controlled under section 38 of the Arms Export Control Act (22 U.S.C. 2778).

SEC. 1516. RELATED ITEMS DEFINED.

In this subtitle, the term ``related items'' means the satellite fuel, ground support equipment, test equipment, payload adapter or interface hardware, replacement parts, and non-embedded solid propellant orbit transfer engines described in the report submitted to Congress by the Department of State on February 6, 1998, pursuant to section 38(f) of the Arms Export Control Act (22 U.S.C. 2778(f)).

ITAR Regulations – 22 CFR 120-130

§ 120.1 General authorities and eligibility

(a) Section 38 of the Arms Export Control Act (22 U.S.C. 2778) authorizes the President to control the export and import of defense articles and defense services. The statutory authority of the President to promulgate regulations with respect to exports of defense articles and defense services was delegated to the Secretary of State by Executive Order 11958, as amended. This subchapter implements that authority. By virtue of delegations of authority by the Secretary of State, these regulations are primarily administered by the Deputy Assistant Secretary for Defense Trade Controls and Managing Director of Defense Trade Controls, Bureau of Political-Military Affairs.

§ 120.2 Designation of defense articles and defense services.

The Arms Export Control Act (22 U.S.C. 2778(a) and 2794(7)) provides that the President shall designate the articles and services deemed to be defense articles and defense services for purposes of this subchapter. The items so designated constitute the United States Munitions List and are specified in part 121 of this subchapter. Such designations are made by the Department of State with the concurrence of the Department of Defense. For a determination on whether a particular item is included on the U.S. Munitions List *see* §120.4(a).

ITAR Regulations – 22 CFR 120-130

§ 120.3 Policy on designating and determining defense articles and services.

An article or service may be designated or determined in the future to be a defense article (see §120.6) or defense service (see §120.9) if it:

(a) Is specifically designed, developed, configured, adapted, or modified for a military application, and

(i) Does not have predominant civil applications, and

(ii) Does not have performance equivalent (defined by form, fit and function) to those of an article or service used for civil applications; or

(b) Is specifically designed, developed, configured, adapted, or modified for a military application, and has significant military or intelligence applicability such that control under this subchapter is necessary.

The intended use of the article or service after its export (*i.e.* , for a military or civilian purpose) is not relevant in determining whether the article or service is subject to the controls of this subchapter. Any item covered by the U.S. Munitions List must be within the categories of the U.S. Munitions List. The scope of the U.S. Munitions List shall be changed only by amendments made pursuant to section 38 of the Arms Export Control Act (22 U.S.C. 2778).

§ 121.1 General. The United States Munitions List.

(a) The following articles, services and related technical data are designated as defense articles and defense services pursuant to §§38 and 47(7) of the Arms Export Control Act (22 U.S.C. 2778 and 2794(7))….

ITAR Regulations – 22 CFR 120-130

§ 121.1 General. The United States Munitions List (Continued)
Category XV—Spacecraft Systems and Associated Equipment

*(a) Spacecraft, including communications satellites, remote sensing satellites, scientific satellites, research satellites, navigation satellites, experimental and multi-mission satellites.

*Note to paragraph(a): Commercial communications satellites, scientific satellites, research satellites and experimental satellites are designated as SME only when the equipment is intended for use by the armed forces of any foreign country.

(b) Ground control stations for telemetry, tracking and control of spacecraft or satellites, or employing any of the cryptographic items controlled under category XIII of this subchapter.

(c) Global Positioning System (GPS) receiving equipment specifically designed, modified or configured for military use; or GPS receiving equipment with any of the following characteristics:

(1) Designed for encryption or decryption (e.g., Y-Code) of GPS precise positioning service (PPS) signals;

(2) Designed for producing navigation results above 60,000 feet altitude and at 1,000 knots velocity or greater;

(3) Specifically designed or modified for use with a null steering antenna or including a null steering antenna designed to reduce or avoid jamming signals;

(4) Designed or modified for use with unmanned air vehicle systems capable of delivering at least a 500 kg payload to a range of at least 300 km.

ITAR Regulations – 22 CFR 120-130

§ 121.1 General. The United States Munitions List
Category XV—Spacecraft Systems and Associated Equipment (Continued)

(d) Radiation-hardened microelectronic circuits that meet or exceed all five of the following characteristics:

(1) A total dose of 5×10^5 Rads (Si);
(2) A dose rate upset threshold of 5×10^8 Rads (Si)/sec;
(3) A neutron dose of 1×10^{14} n/cm^2 (1 MeV equivalent);
(4) A single event upset rate of 1×10^{-10}errors/bit-day or less, for the CREME96 geosynchronous orbit, Solar Minimum Environment;
(5) Single event latch-up free and having a dose rate latch-up threshold of 5×10^8 Rads (Si).

(e) All specifically designed or modified systems or subsystems, components, parts, accessories, attachments, and associated equipment for the articles in this category, including the articles identified in section 1516 of Public Law 105–261: satellite fuel, ground support equipment, test equipment, payload adapter or interface hardware, replacement parts, and non-embedded solid propellant orbit transfer engines (see also Categories IV and V in this section).

Note: This coverage by the U.S. Munitions List does not include the following unless specifically designed or modified for military application (see §120.3 of this subchapter):

(1) Space qualified travelling wave tubes (also known as helix tubes or TWTs), microwave solid state amplifiers, microwave assemblies, and travelling wave tube amplifiers operating at frequencies equal to or less than 31GHz.

ITAR Regulations – 22 CFR 120-130

§ 121.1 General. The United States Munitions List
Category XV—Spacecraft Systems and Associated Equipment (Continued)

(2) Space qualified photovoltaic arrays having silicon cells or having single, dual, triple junction solar cells that have gallium arsenide as one of the junctions.
(3) Space qualified tape recorders.
(4) Atomic frequency standards that are not space qualified.
(5) Space qualified data recorders.
(6) Space qualified telecommunications systems, equipment and components not designed or modified for satellite uses.
(7) Technology required for the development or production of telecommunications equipment specifically designed for non-satellite uses.
(8) Space qualified focal plane arrays having more than 2048 elements per array and having a peak response in the wavelength range exceeding 300nm but not exceeding 900nm.

Thriving in a Global Economy
The Truth about U.S. Manufacturing and Trade

by Daniel Ikenson

Executive Summary

Reports of the death of U.S. manufacturing have been greatly exaggerated. Since the depth of the manufacturing recession in 2002, the sector as a whole has experienced robust and sustained output, revenue, and profit growth. The year 2006 was a record year for output, revenues, profits, profit rates, and return on investment in the manufacturing sector. And despite all the stories about the erosion of U.S. manufacturing primacy, the United States remains the world's most prolific manufacturer—producing two and a half times more output than those vaunted Chinese factories in 2006.

Yet, the rhetoric on Capitol Hill and on the presidential campaign trail about a declining manufacturing sector is reaching a fevered pitch. Policymakers point repeatedly to the loss of 3 million manufacturing jobs as evidence of impending doom, even though those acute losses occurred between 2000 and 2003, and job decline in manufacturing has leveled off to historic averages.

In the first six months of the 110th Congress, more than a dozen antagonistic or protectionist trade-related bills have been introduced, which rely on the presumed precariousness of U.S. manufacturing as justification for the legislation. Justification for those bills is predicated on the belief that manufacturing is in decline and that the failure of U.S. trade policy to address unfair competition is to blame. But those premises are wrong. The totality of evidence points to a robust manufacturing sector that has thrived on account of greater international trade.

Daniel Ikenson is associate director of the Center for Trade Policy Studies at the Cato Institute. He is coauthor of Antidumping Exposed: The Devilish Details of Unfair Trade Law *(Cato Institute, 2003).*

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Reports of the death of U.S. manufacturing have been greatly exaggerated.

Introduction

A certain fallacy has taken hold in Washington. Too many lawmakers are operating under a mistaken trio of assumptions: that U.S. manufacturing is on the decline, that unfair foreign competition explains that decline, and that failure to formulate a policy response to arrest and reverse that trend imperils the nation's future. The ascent of those views on Capitol Hill is a testament to the power of exaggeration, repetition, and indignation, and is a profound disservice to the truth. Some very bad policy options, predicated on those myths, are now under consideration in Congress.

Reports of the death of U.S. manufacturing have been greatly exaggerated. It is true that the number of workers employed in U.S. manufacturing industries declined by about three million between 2000 and 2003. It is also true that real wage growth in manufacturing has been anemic since the manufacturing recession earlier in the decade. And it is correct that the manufacturing sector's contribution to GDP has been shrinking. But those data are not evidence of a declining manufacturing sector or unfair trade competition. At most, they shed some light on a sector that is in transition. And during that transition, some phenomenal operating results have been registered.

Since the nadir of the manufacturing recession in 2002, the sector as a whole has experienced robust and sustained output, revenue, and profit growth, achieving gains in all three for four straight years. Two thousand and six was a record year for output, revenues, profits, profit rates, and return on investment in the manufacturing sector. And, despite all the stories about the erosion of U.S. manufacturing primacy, the United States remains the world's most prolific manufacturer—producing two and a half times more output in 2006 than those much-celebrated Chinese factories.

Of course, manufacturing is not monolithic. It comprises a variety of industries, each facing different economic circumstances. Some industries may be doing very well, while others struggle to adapt to changing circumstances. According to the findings presented in this paper, for every two U.S. manufacturing industries that experienced increases in revenue, one experienced a decline; for every two that saw their profits increase, one saw its profits decline; for every two that experienced increases in output, one experienced falling output. Thus, roughly two-thirds of U.S. manufacturing is doing well by the most traditional metrics of economic health. What about the other third? Can their lagging health be attributed to increased foreign competition? If so, are policymakers justified in intervening to try to change the tide?

This paper seeks to present the facts about the condition of U.S. manufacturing, while dispensing with some persistent myths along the way.

Proliferating Myths

Washington is abuzz with talk of U.S. manufacturing demise. Protectionists on the op-ed pages, on the airwaves, and in Congress emphasize the decline of U.S. manufacturing at the hands of insidious foreign competition, which has been enabled (if not encouraged) by an administration that has ignored the plight of blue-collar America, while tolerating unfair foreign trade practices. Reinforcing that perspective are the opinions expressed almost nightly by television talk show hosts, who seem more intent on stoking controversy than on providing a forum for honest debate.

The thrust of those messages, which continue even after several consecutive years of recovery and strong operating performance within the manufacturing sector, is that new trade policies are needed to arrest the decline of U.S. manufacturing, which would otherwise be in excellent financial health, and a reliable engine of U.S. job growth. Averting new, playing-field-leveling trade policies in the near term, so the message goes, will further erode U.S. capacity to maintain its position of global economic preeminence.

Several years into this campaign, and long after the facts on the ground have changed significantly, that message is gaining traction with

policymakers. One reason for the traction is that political action tends to lag behind economic or social circumstances. In 2007 we are five years beyond the nadir of the U.S. manufacturing recession, well into recovery and even record territory. Yet, Congress appears keen to act on behalf of the sector, as if its troubles weren't several years removed. Another reason has to do with the change in control of Congress last November. An agenda that caters to the wishes of labor—and its manufacturing industry benefactors—is more likely to resonate with the new Democratic majority.

The political story of manufacturing is all about job losses. Between 2000 and 2003, the number of workers employed in the U.S. manufacturing sector declined from around 17.3 million to around 14.5 million—a drop of 2.8 million workers.[1] But since then the rate of decline has reverted to the much more modest, decades-long manufacturing average. Between 2003 and 2006, the number of workers employed in the sector dropped to 14.2 million—a decline of only 300,000 workers.[2] And on top of that picture of stabilizing manufacturing employment, nearly all relevant statistics point to a thriving manufacturing sector.

Yet the three million jobs lost figure has become emblematic of some presumed failure of policy. That number has been cited and repeated so frequently that it is treated with a certain solemnity, a false significance, which far exceeds its utility as a measure of the condition of U.S. manufacturing then or now. The fact that the U.S. manufacturing sector has recovered fully from its recession in 2001–02, and has even reached new heights with respect to several important indicia, has been nearly totally lost in the political debate about what must be done to save manufacturing.

In March the congressional leadership unveiled its "New Trade Policy for America," which contains several policy bullet points, including the following: "Democrats offer a trade policy that will [among other things] stand up for American workers, farmers, and businesses, *especially in the hard-hit U.S. manufacturing sector*."[3] Democrats advocate better enforcement of trade agreements to "ensure that countries play by the rules so that trade is a two-way street."[4]

For the record, last year the "hard-hit" manufacturing sector produced more output than at any other time in history, while achieving record sales and record profits (in constant dollar terms). Likewise, U.S. manufacturing exports reached record highs. Thus, trade is already a two-way street, and policymakers should resist any measures that might impede its flow.

Lawmakers are so keen to be seen doing something for manufacturing that many appear unwilling to acknowledge the sector's tremendous recovery. Such acknowledgement could deprive them of an opportunity to report back to their constituents how hard they are working for the American family.

Testifying recently at a House Ways and Means Committee trade subcommittee hearing on the merits of the Nonmarket Economy Trade Remedy Act of 2007 (a bill to, among other things, authorize the application of countervailing duties against nonmarket economies), Rep. Peter Visclosky (D-IN) offered, "My message, simply put, is that if we are to maintain a manufacturing base in the United States, we *must* have zero tolerance for unfair and illegal trade. . . . If our companies cannot count on a level playing field, then U.S. manufacturing has no long-term future."[5] Visclosky should also consider the growing importance of export markets to U.S. manufacturers lest he think there is nothing to lose by enacting aggressive trade legislation.

In May, Democratic members of the Michigan congressional delegation as well as the state's governor issued their "American Manufacturing Initiative," billed as a "comprehensive initiative to revitalize U.S. manufacturing."[6] In offering his support of the initiative, Sen. Carl Levin (D-MI) opined that "the Bush Administration has not lifted a finger to support manufacturing in America while we have lost three million manufacturing jobs on its watch."[7] Rep. John Dingell (D-MI), another sponsor of the initiative, declared: "Manufacturers are hurting in large part due to this Administration's lax attitude toward unfair trade practices."[8]

In fairness, Michigan's political representatives may have reason to despair about their

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manufacturing industries. While the rest of U.S. manufacturing has recovered, Michigan's manufacturing economy remains stagnant. Real GDP growth between 2005 and 2006 in Michigan ranked dead last among the 50 states. Meager manufacturing value-added growth contributed only 0.05 percentage points to what was a net contraction of the state's economy to the tune of -0.5 percent. Nationwide, the contribution of manufacturing was .41 percentage points to an overall GDP growth rate of 3.4 percent. Had Michigan's manufacturing sector been able to contribute as much as neighboring Indiana's manufacturing sector did to its overall economy, Michigan's economy would have actually grown—by 0.3 percent.[9]

The strength of manufacturing outside of Michigan is strong evidence that unfair trade and the administration's allegedly lax attitude toward it are not to blame for Michigan's problems. Manufacturing's woes in that state likely have more to do with the relatively high level of labor force unionization, restrictive work rules, and state laws and regulations that deter investment and business formation there.

In the presidential debates, candidates from both major parties have spoken about our fragile manufacturing sector and the unwillingness of the current president to respond with get-tough trade policies. Responding to a question by Chris Matthews about how he would be different from President Bush, Republican candidate Duncan Hunter offered: "You know, we won World War II, World War I and the Cold War with a major industrial base. We're losing our industrial base through bad trade policy right now. China is cheating on trade. I would enforce trade laws. That's something that the president is not doing."[10]

A top priority of Democratic candidate Dennis Kucinich would be to "cancel NAFTA, cancel the WTO, go back to bilateral trade conditioned on workers' rights, [and] human rights."[11]

Even the Democratic presidential frontrunner, Sen. Hillary Clinton, has been perpetuating the myth and spreading fear about the impact of trade on manufacturing. Voicing her opposition to the pending U.S.-South Korea Free Trade Agreement, Senator Clinton opined: "While I value the strong relationship the United States enjoys with South Korea, I believe that this agreement is inherently unfair. It will hurt the U.S. auto industry, increase our trade deficit, cost us good middle-class jobs and make America less competitive."[12]

And it's not only the politicians hemming about manufacturing and trade. Informing policymakers' perspectives are trade associations and lobbying groups promoting legislation that will give them an advantage over their competition. All too often, they are aided in these efforts by print and broadcast reporters who like sensationalistic and economically divisive stories. And sometimes the testimony of pro-protection experts is no better grounded in economics than the nightly commentaries of CNN's Lou Dobbs. According to recent congressional testimony of by Lawrence Mishel, an economist from the pro-union Economic Policy Institute:

> For working Americans, the effects of the enormous growth in foreign trade have been mostly negative, resulting in the loss of good-paying manufacturing jobs, significant downward pressure on wages, and increased inequality. The doubling of trade as a share of our economy over the last 25 years has been accompanied by a massive trade deficit, directly displacing several million jobs. Most of these jobs were in the manufacturing sector, which included millions of union jobs that paid better-than-average wages. In just the five years from 2000–05, more than three million manufacturing jobs disappeared. We estimate that at least one-third of that decline was caused by the rise in the manufactured goods trade deficit.[13]

To paint this gloomy picture, Mishel ignores a host of economic facts. Since 1980 trade as a share of U.S. GDP has increased by 130 percent.[14] Imports alone have increased six-fold.[15] But that huge growth in trade has

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occurred alongside the creation of 46 million net new jobs in the United States since 1980—1.8 million net new jobs per year.[16] Meanwhile the average U.S. unemployment rate has decreased in each successive decade: in the 1980s, it was 7.3; in the 1990s, it was 5.8; and, since 2000, it has been 5.1.[17] As of June 2007, the unemployment rate stood at 4.5 percent.

Given the manufacturing sector's return to record sales and profitability after the phase-out of those "better-than-average" paying union jobs, the competitive burdens imposed on manufacturers by union rules and wages should be obvious.

Despite U.S. manufacturing's overall health, in the 109th Congress more than two dozen pieces of trade legislation—most of them aimed at China—were introduced. In less than the first six months of the 110th Congress, more than one dozen pieces of trade legislation were introduced in response to, among other things, the presumed precariousness of U.S. manufacturing.[18]

Section 1, paragraph 8 of H.R. 294, which would prohibit the United States from negotiating or entering into any new bilateral or regional trade agreements for a period of two years, reads: "United States trade policies have had a devastating impact on the manufacturing sector in the United States; an estimated 2,800,000 manufacturing jobs in the United States have been lost since 2001."[19]

Likewise, section 1, paragraph 3 of H.R. 1002, a bill to impose import duties on Chinese goods unless and until China revalues its currency to the satisfaction of the Congress, is premised on the alleged impact of currency manipulation on U.S. manufacturing. It reads: "China's undervalued currency and the United States trade deficit with the People's Republic of China is contributing to significant United States job losses and harming United States business. In particular, the United States manufacturing sector has lost more than 3,009,000 jobs since January 2001."[20]

Those urgent calls to arms rely on two premises: that U.S. manufacturing is in decline and that the failure of U.S. trade policy to address unfair competition is to blame. But accepting those premises requires neglect of the abundant evidence to the contrary. The totality of evidence points to a robust manufacturing sector. If that were understood by policymakers, they might be less quick to endorse provocative trade policies, particularly given that manufacturers are America's chief importers, and export markets have been manufacturing's greatest source of growth in recent years.

The Real State of U.S. Manufacturing

By historic standards and relative to other countries' manufacturing sectors, U.S. manufacturing is in very good condition today. Those who speak of the demise of manufacturing often cite a few select facts: the decline in manufacturing employment, that sector's diminishing contribution to gross domestic product, and the stagnation of real manufacturing wages. Those are important statistics, which should be considered in context and weighed in conjunction with other relevant data if informed conclusions are to be reached and bad policy choices avoided.

Consider the following facts. In 2006, amid record imports of manufactured products:

- Real U.S. manufacturing output reached an all-time high.
- Real manufacturing revenues reached an all-time high.
- Real manufacturing operating profits reached an all-time high.
- After-tax profit rates for manufacturing corporations reached an all-time high.
- Return on equity for manufacturing corporations reached an all-time high.
- The value of U.S. manufacturing exports reached an all-time high.
- U.S. factories remained the world's most prolific, accounting for over a fifth of world manufacturing value added.

Given these facts, it is extraordinarily difficult to make a serious case that our manufacturing sector has been hard hit or is in decline. Should we lament the loss of high-paying union jobs when the subsequent output and productivity statistics make clear that those jobs were highly overpaid? With an overall unemploy-

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In 2006 real output was 13 percent higher than in 2001, the year before the first full year of China's membership in the World Trade Organization.

ment rate of 4.5 percent and average wages outside of manufacturing surpassing average manufacturing wages for the first time ever in 2006, it takes real creativity to paint a picture of gloom and doom.[21] And does real manufacturing wage stagnation tell the full story of employee remuneration when firms cover a large part of their employees' dramatically increasing health care costs? Real wage growth is held back by inclusion of those inflating health care costs in the consumer price index (i.e., the denominator). Since employers cover a large part of those costs, they should be considered in the numerator as well, to ensure an apples-to-apples comparison. That's why total compensation, and not wages, is the proper metric of employee remuneration.

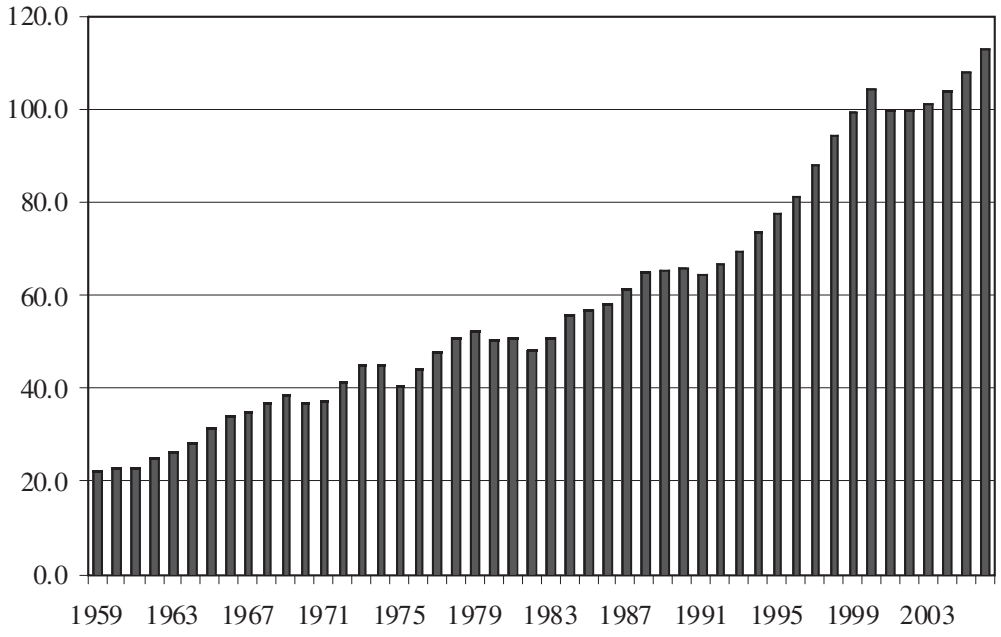
What about output and value added increases? How about record revenues and profits? Do they count for anything? Hasn't trade been a large net plus for the sector?

Output

As Figure 1 demonstrates, U.S. manufacturing output reached its highest level ever in 2006. After declining by about four percent from 2000 to 2001 and remaining stagnant in 2002, output returned to its upward trajectory in 2003. In 2006 real output was 13 percent higher than in 2001, the year before the first full year of China's membership in the World Trade Organization. It was 53 percent higher than in 1994, the oft-cited "beginning of the end" for manufacturing as the North American Free Trade Agreement took effect, the Chinese government pegged its currency at about 8 yuan to the dollar, and Congress ratified the Uruguay Round Agreements Act, cutting trade barriers and establishing the World Trade Organization. It was well more than double the output of 1980, when imports were only 16 percent of their 2006 level; and it was more than five times greater than output in 1960, when the U.S. trade deficit was only 2 percent of its 2006 value.

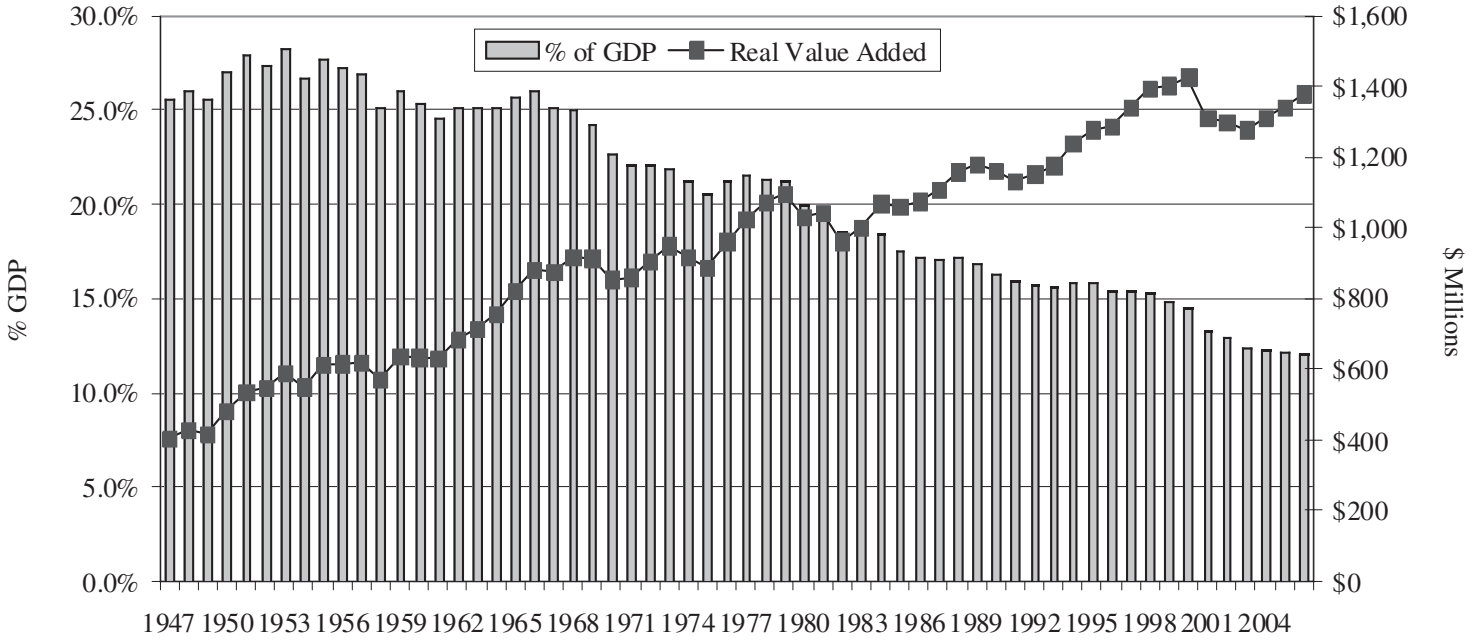
In other words, U.S. factories have continuously churned out more output year after year (with the exception of brief retractions during economic recessions) regardless of the decline in manufacturing employment and regardless

Figure 1
Real U.S. Manufacturing Output, 1959–2006 (Indexed to 2002 Output)



Source: *Economic Report of the President, 2007*, Table B-51.

Figure 2
Manufacturing Value Added, % of GDP and Real Value Added(1947–2006)



Source: Bureau of Economic Analysis, GDP-by-Industry Accounts, http://www.bea.gov/industry/gpotables/gpo_action.cfm.

of import levels. Thus, job attrition and rising imports are not particularly useful measures of the health of U.S. manufacturing, even though they are among the most frequently cited "evidence" of domestic decline.

Instead, the employment and output figures considered together suggest that with greater rates of labor productivity, far fewer workers are needed on the production line. The import and output figures considered together confirm findings reported by Daniel Griswold, whose research indicates a strong correlation between manufacturing imports and manufacturing output. They have risen and fallen together over a long time horizon.[22]

U.S. manufacturers are among America's largest importers. In 2006, "industrial supplies and material," and "capital goods (except automotive)" comprised nearly 55 percent of all imports.[23] Those are the purchases of U.S. companies—not consumers. They are raw materials, components, and other intermediate goods used in the production of final products in the United States. Thus, access to foreign-produced components, materials, and sources of energy are essential to U.S. manufacturers' profitability. With access to imports compromised by trade restraints or a weaker dollar, costs of production tend to be higher, and profits tend to be lower.

Since imports are so crucial to U.S. manufacturers, some would suggest that total manufacturing output is a figure that obscures the true picture of the activity of U.S. factories. If a large portion of the final product comprises imported components, then assigning the total value of output to U.S. production inflates the portion of output that should be attributed to U.S. plants and workers. Accordingly, value added in U.S. plants is the more appropriate measure of U.S. output. And that metric, the skeptics suggest, reveals a manufacturing sector in decline.

As Figure 2 reveals, manufacturing value added is indeed declining as a percentage of the total U.S. economy. That's not a recent phenomenon, though. Manufacturing's share of GDP peaked in 1953, when it comprised 28.3 percent of the economy, and has been declining almost

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continuously ever since. Today it accounts for just over 12 percent of the economy.

Declining relative contribution of manufacturing to total economic output is true of all developed countries. Just as the agricultural sectors yielded in significance to the emerging manufacturing sectors during the 19th century, manufacturing has been yielding to services for the past half century. This process is nothing to be alarmed by, yet protectionists cite those statistics as though they were a sign of impending doom.

Although contribution to GDP provides information about the relative size of manufacturing, it reveals nothing about its health. Declining share of GDP is not a sign of manufacturing weakness, but a testament to the relative size and growing importance of the U.S. services sector, which has expanded more rapidly than manufacturing. In absolute terms, manufacturing value added has been increasing nearly every year since the end of World War II. For three straight years following the manufacturing recession, value added has been increasing. The $1.38 trillion level reached in 2006 was the highest level since the $1.43 trillion level in 2000, which was an all-time record for manufacturing value added.

Still, skeptics point out that U.S. manufacturing output growth has been mild relative to the growth experienced in other countries. Perennial, double-digit percentage increases in China's rate of economic growth relative to the steady but lower rates of growth in the United States have produced squeals of panic.

According to commentator and former presidential candidate Pat Buchanan, last year "China's economy grew by 10 percent—and by 140 percent over the last 10 years, tripling the growth in the United States. Not only are we shipping factories, technology, equipment and jobs to China, we are exporting our future to China."[24] While the growth rates differential may be true, Buchanan's point is as hyperbolic as it gets. As the world's largest manufacturer, starting from a large base of output, the United States would have difficulty growing at the same pace as a rapidly expanding developing country's manufacturing sector, where base year outputs are much smaller. Smaller economies experience higher rates of growth for each incremental increase in output, relative to larger economies, because their bases are smaller.

A more informative benchmark for considering relative sizes and growth rates of different countries' manufacturing output is share of total world output over time. According to the United Nations Industrial Development Organization, the U.S. share of world manufacturing output, on a value-added basis, has remained steady for more than a decade. In 2005, U.S. factories accounted for 21.1 percent of the world's manufacturing output, which was only a very small decline from their 1993 share of 21.4 percent. Over that same period, Japan's share declined from 22.4 percent to 19.0 percent, and the combined share of the 27 members of the European Union declined from 29.3 percent to 26.5 percent. Meanwhile, China's share of world manufacturing value added increased from 3.5 percent in 1993 to 8.0 percent in 2005.[25]

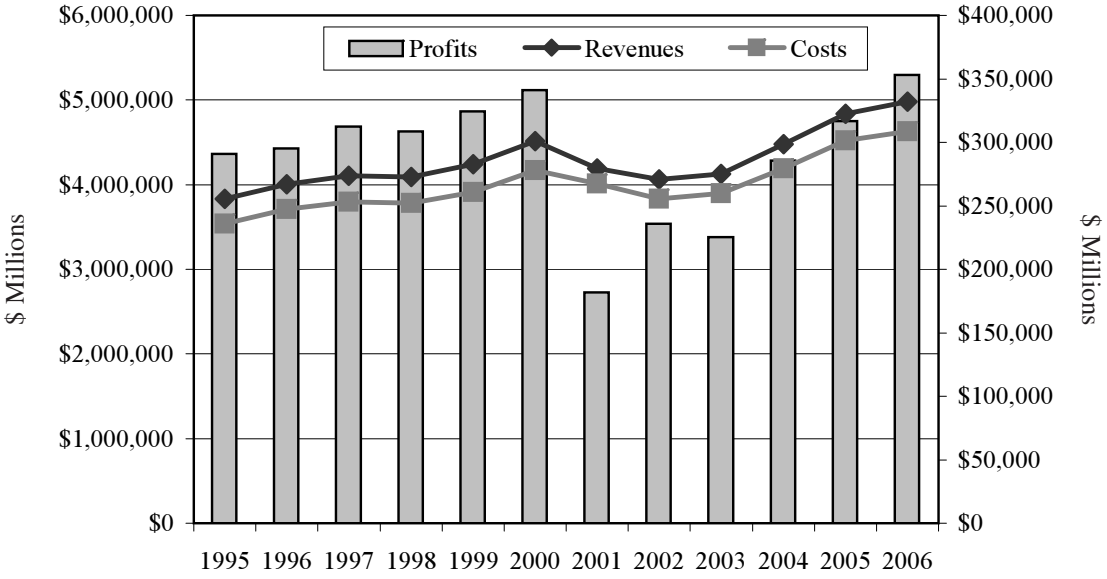
Thus, on a global basis, U.S. manufacturing continues to retain its position of primacy. Despite the alarmist rhetoric, U.S. factories are the most prolific in the world. Although China's share of world manufacturing output more than doubled between 2000 and 2005, U.S. producers still churn out 2.5 times the value added coming from Chinese factories.

Operating Performance

To complement the record output just established, U.S. manufacturing recorded its strongest financial performance ever in 2006. As Figure 3 indicates, after four consecutive years of sales revenue growth—representing a 22.5 percent increase since 2002—revenues hit a record of nearly $5 trillion in 2006.[26] After declining slightly from 2002 to 2003, operating profits increased for three straight years and by a total of 57 percent to reach a record $353 billion in 2006.[27]

Most remarkable, perhaps, in light of all of the hand wringing about manufacturing's dire straits is that for the first time ever (or at least since the data show, going back to 1947), after-tax manufacturing profit rates broke through

Figure 3
All Manufacturing Revenues, Costs, and Profits (in Constant Million $)



Note: Revenues and costs measured on left Y-axis; Profits measured on right Y-axis.
Source: Bureau of the Census, Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations (First Quarter 1995–Fourth Quarter 2006).

the 8 percent mark in 2006. Likewise, for the first time ever, return on equity in the sector exceeded an astounding 18 percent.[28] Thus, based on production and operating performance, U.S. manufacturing appears to be firing on all cylinders.

Employment/Productivity

Though the trend has been evident for decades, the first few years of this decade witnessed an accelerated decline in manufacturing employment. The loss of about 3 million manufacturing jobs has been used as a call to arms by those who see the manufacturing sector as under assault by foreign competition. But employment statistics are fairly uninformative as evidence of the health of an industry or sector.

As manufacturing employment has declined, value added per worker has increased (see Figure 4).

Declining employment in a sector that is producing record output is hardly credible evidence of doom. In fact, the two indicators taken together are evidence of rising labor productivity, which, as the source of long-term increases in living standards, is something to cheer. As Harvard Business School professor Michael Porter put it in his influential book, *The Competitive Advantage of Nations*:

> A nation's standard of living in the long term depends on its ability to attain a high and rising level of productivity in the industries in which its firms compete.[29]

When manufacturers can produce more output with fewer and less costly inputs, that's called progress. With the national unemployment rate at 4.5 percent, 1.8 million net new jobs created each year, U.S. plants producing record output, and manufacturing companies earning record profits, what is so troubling about the loss of manufacturing jobs?

Compensation

The notion that most of the jobs lost were high-paying union manufacturing jobs and the

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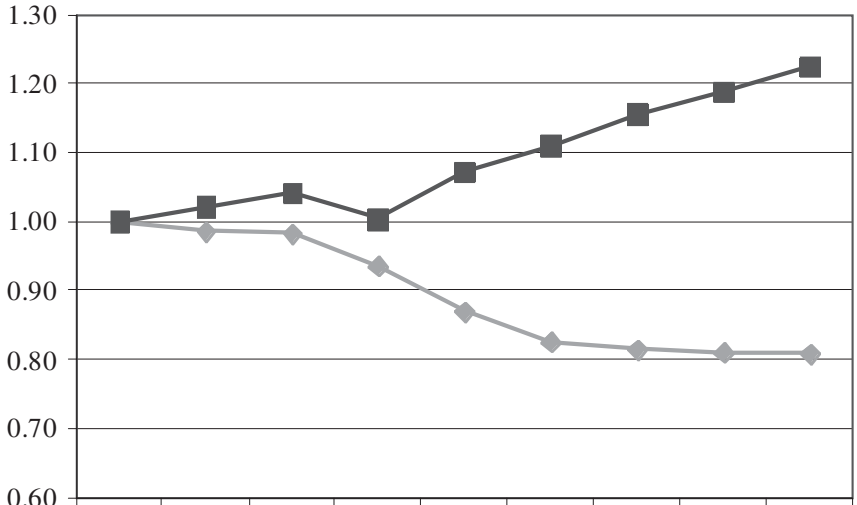
Figure 4
Manufacturing Employment and Value Added per Worker 1998–2006
(Data Indexed to 1998 Values)



	1998	1999	2000	2001	2002	2003	2004	2005	2006
Employment	1.00	0.99	0.98	0.94	0.87	0.83	0.81	0.81	0.81
VA per Worker	1.00	1.02	1.04	1.00	1.07	1.11	1.16	1.19	1.22

Source: Bureau of Economic Analysis.

new jobs obtained were all lower-paying service sector positions is also a myth. Not only are there many more jobs in the services sector than in manufacturing, but, contrary to popular misconception, the average wage paid in the services sector is higher than the average wage in the manufacturing sector.

According to a 2003 Commerce Department study, "Manufacturing in America," which provided a comprehensive assessment of the state of U.S. manufacturing as it began its recovery from recession:

> Manufacturing's advantage in total compensation is based on benefits, rather than higher hourly wages. Average hourly earnings of production workers since 1967, when measured on an inflation-adjusted basis, suggest that manufacturing as a sector has offered an average, rather than high, hourly wage. There are, of course, specific sectors such as autos and steel that have offered wages far above the average, but these are balanced by others that have offered below average wages. In fact, the average hourly earnings in the wholesale trade, finance, and services sectors have surpassed those in manufacturing over the past 10 years; only retail trade remains lower.[30]

Real wage growth in manufacturing has been somewhat stagnant over the course of this decade. That would seem to suggest that the benefits of any productivity gains are not going to the workers. But wages are only a part of total compensation, which includes retirement, health care, other insurance, vacation pay, and other expenses. The costs of health insurance, in particular, have been increasing much faster than the consumer price index as a whole. Thus, the value of benefits employees receive has been increasing. The Commerce study provides some illuminating data on the topic:

> The advantage of working in the manufacturing sector has derived, instead,

Wages are only a part of total compensation, which includes retirement, health care, other insurance, vacation pay, and other expenses.

from the higher level of average benefits received ($8.89 per hour for manufacturing versus $5.94 for non-manufacturing). Manufacturers contribute an average of $0.81 per hour more for health insurance, $0.66 more for overtime and supplemental pay, $0.62 more for leave, $0.29 more for retirement, and $0.34 more for other benefits.[31]

Benefits continue to be a large part of manufacturing compensation, and total compensation has been rising since the recession. For manufacturing workers, real wages increased by a total of 4 percent between 2001 and 2005, while real benefits increased by 42 percent.[32] Compensation for manufacturing workers was up 11 percent, as opposed to 6 percent for the economy as a whole.

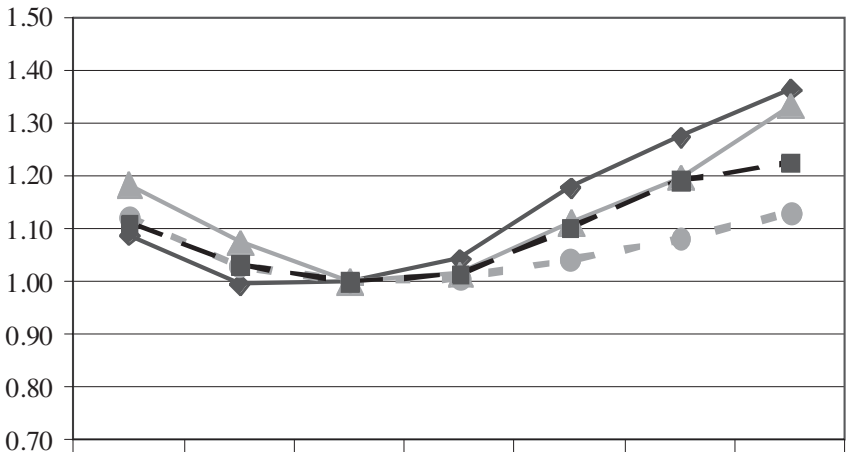
Trade

As described above, the rising level of U.S. imports and exports has been associated with positive developments in key manufacturing performance indicia. As Figure 5 illustrates, changes in output, exports, and revenues closely track changes in imports, whereas Figure 6 demonstrates the relative unresponsiveness of compensation and employment to changing levels of imports. As manufactured imports declined in 2001 and 2002, manufacturing output, exports, and revenues declined as well. When imports began to pick up again as the manufacturing recession was ending, all of those real variables tracked upwards, adding yet more data points to the line that confirms a strong positive correlation. Contrary to the assertions of trade bashers, changes in compensation and employment appear to have been unaffected by changes in imports.

The premise that U.S. manufacturing is under duress from imports is not supported by the data, which instead indicates record manufacturing performance by the most relevant measures. As manufacturing imports have achieved new heights, manufacturing output,

The premise that U.S. manufacturing is under duress from imports is not supported by the data.

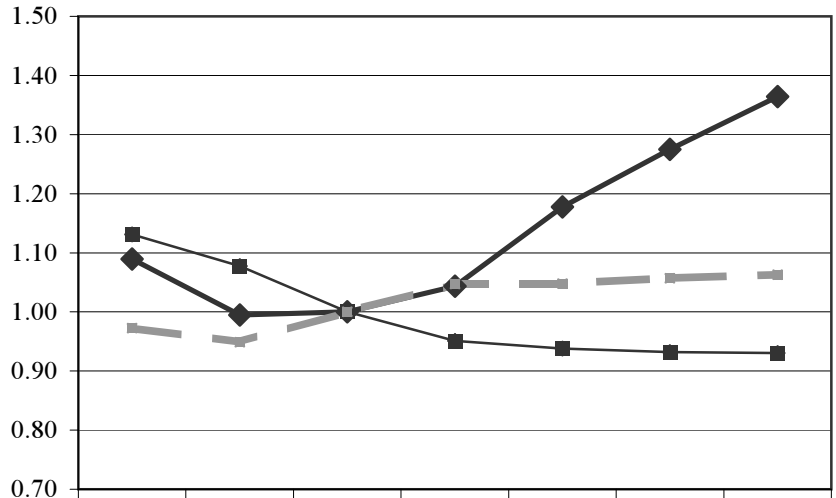
Figure 5
Real Imports, Real Output, Real Exports, and Real Revenues, 2000–2006 (Values Indexed to 2002)



	2000	2001	2002	2003	2004	2005	2006
Imports	1.09	0.99	1.00	1.04	1.18	1.27	1.36
Output	1.12	1.03	1.00	1.01	1.04	1.08	1.13
Exports	1.18	1.07	1.00	1.02	1.11	1.20	1.33
Revenues	1.11	1.03	1.00	1.01	1.10	1.19	1.23

Source: U.S. International Trade Commission (imports and exports); Bureau of Economic Analysis (output); Bureau of the Census (revenues).

Figure 6
Real Imports, Real Compensation, and Employment, 2000–2006 (Values Indexed to 2002)



	2000	2001	2002	2003	2004	2005	2006
Imports	1.09	0.99	1.00	1.04	1.18	1.27	1.36
Employ (BLS All)	1.13	1.08	1.00	0.95	0.94	0.93	0.93
Compensation	0.97	0.95	1.00	1.05	1.05	1.06	1.06

Source: U.S. International Trade Commission (imports); Bureau of Economic Analysis (employment and compensation).

revenues, exports, and profits have all set records, too. Trade is an important part of that success story: greater access to raw materials and components has helped control costs of production, while greater access to foreign markets has been crucial to surging sales revenues.

Adopting bellicose rhetoric toward trade partners and agitating for restrictive policies would be shortsighted even if there were wide-ranging problems within the manufacturing sector. U.S. manufacturers account for more than half of all U.S. import value. Just injecting uncertainty into the trade and investment climate, not to mention imposing restrictions, would likely lead to higher costs. Insisting on Chinese currency revaluation and risking retaliation by supporting provocative measures to compel that outcome, when the consequences of a rising Yuan could include higher raw materials' costs for U.S. producers is simply playing with fire. The same presumed dynamic that would deter U.S. consumers from purchasing Chinese goods would affect U.S. producers by driving up their costs; and stronger Chinese demand for commodities and other materials, on account of a stronger currency, would also put upward pressure on the prices of oil, rubber, copper, iron ore, and other commodities needed by U.S. producers and paid for by U.S. consumers.

Adopting bellicose rhetoric toward trade partners and agitating for restrictive policies would be shortsighted even if there were wide-ranging problems within the manufacturing sector.

The data presented above indicate that the U.S. manufacturing sector is doing quite well, as a whole. But averages can obscure acute circumstances. To be sure, U.S. manufacturing is not monolithic. It comprises a variety of industries, each facing different conditions of competition for inputs and customers, each requiring different mixes of labor and capital, and each facing differing degrees and manifestations of competition from foreign producers. Skill sets of workers, exposure to international competition, volatility of the market, ability to attract capital, and other factors can differ dra-

matically across industries. Some industries may be doing exceptionally well by historic standards and relative to their foreign competition, while others might be struggling by either standard or both. Some industries might be enjoying the fruits of international trade—better and more cost-effective access to raw materials and production components as well as access to bigger markets for their final products—while others have simply struggled to eke out profits as international trade has grown over the decades.

The remainder of this paper is devoted to assessing the state of U.S. manufacturing and the impact of trade on an industry-specific basis by presenting and evaluating objective, commonly used government data on operating performance, output, employment, compensation, and trade. As described in greater detail below, most industries within the manufacturing sector are doing well by those measures. The few that are not performing well—that have experienced declining revenues, profits, and output—are those less technologically intensive industries characterized by a lower-skilled workforce and lower wages.

In effect, the picture that emerges from these data about U.S. manufacturing and trade is a textbook explanation of comparative advantage. U.S. manufacturing, although declining in terms of its total contribution to U.S. output, is thriving at the higher end of the value chain, while it is atrophying at the lower end.

The Industry-Specific Details

The government agencies that collect data and publish reports on U.S. economic activity often present their findings by industry so that the state of the apparel industry, for example, can be distinguished from the state of the computer and electronics products industry. The most common classification system is the North American Industrial Classification System, which provides for 21 distinct manufacturing industries.[33]

Presented below are the 21 broad (3-digit) manufacturing industries within the NAICS.

- 311, Food Manufacturing
- 312, Beverage and Tobacco Product Manufacturing
- 313, Textile Mills
- 314, Textile Product Mills
- 315, Apparel Manufacturing
- 316, Leather and Allied Product Manufacturing
- 321, Wood Product Manufacturing
- 322, Paper Manufacturing
- 323, Printing and Related Support Activities
- 324, Petroleum and Coal Products Manufacturing
- 325, Chemical Manufacturing
- 326, Plastics and Rubber Products Manufacturing
- 327, Nonmetallic Mineral Product Manufacturing
- 331, Primary Metal Manufacturing
- 332, Fabricated Metal Product Manufacturing
- 333, Machinery Manufacturing
- 334, Computer and Electronic Product Manufacturing
- 335, Electrical Equipment, Appliance, and Component Manufacturing
- 336, Transportation Equipment Manufacturing
- 337, Furniture and Related Product Manufacturing
- 339, Miscellaneous Manufacturing

For each of the 21 industries, data pertaining to production, financial performance, employment, productivity, compensation, and trade were collected and assessed. The data for each of those statistics are presented as appendices, and are referenced throughout the discussion below.

Table 1 provides a consolidated picture of the changes in those data, from which many useful conclusions can be drawn.[34] For each industry, the table includes a percentage change from 2002 (the nadir of the manufacturing recession) through the most recent full year for which data were available (either 2006 or 2005). It also includes a "rank" for each metric, where "1" corresponds to the best change in performance and

U.S. manufacturing is thriving at the higher end of the value chain, while it is atrophying at the lower end.

Table 1
Summary of Changes

NAICS	Industry Description	Revenues % Change 2002–06	Rank	Profits % Change 2002–06	Rank	Output % Change 2002–05	Rank	Value Added % Change 2002–05	Rank	VA/Worker % Change 2002–05	Rank	Compensation % Change 2002–05	Rank	Exports % Change 2002–06	Rank	Imports % Change 2002–06	Rank
MFG	Total Manufacturing	22.5%		49.5%		8.07%		3.34%		10.78%		5.69%		33.22%		36.42%	
324	Petroleum and Coal Products Manufacturing	98.0%	1	452.4%	2	72.93%	1	123.46%	1	137.81%	1	11.73%	4	190.83%	1	161.18%	1
331	Primary Metal Manufacturing	58.7%	2	666.9%	1	29.08%	2	34.54%	2	45.97%	2	8.38%	6	118.61%	2	131.53%	2
327	Nonmetallic Mineral Product Manufacturing	36.8%	3	95.5%	5	9.87%	6	7.25%	8	10.49%	12	4.27%	14	16.03%	13	34.43%	10
333	Machinery Manufacturing	24.5%	6	123.0%	4	10.72%	4	6.35%	9	12.00%	11	7.10%	10	41.09%	5	58.88%	3
325	Chemical Manufacturing	18.9%	7	28.7%	9	12.33%	3	10.90%	6	17.46%	7	7.88%	7	48.29%	4	50.92%	4
337	Furniture and Related Product Manufacturing	33.5%	4	68.8%	7	5.99%	8	10.33%	7	17.68%	5	20.78%	2	35.31%	7	38.69%	8
321	Wood Product Manufacturing	12.8%	12	71.3%	6	10.33%	5	18.36%	3	18.78%	4	6.21%	11	17.73%	12	29.85%	11
332	Fabricated Metal Product Manufacturing	13.4%	10	61.6%	8	3.14%	11	12.29%	4	14.01%	9	2.64%	15	31.17%	8	44.94%	6
334	Computer and Electronic Product Manufacturing	18.4%	8	161.9%	3	0.14%	13	0.72%	10	14.94%	8	11.57%	5	15.20%	14	28.91%	12
326	Plastic and Rubber Products Manufacturing	25.1%	5	22.7%	10	5.19%	9	-4.57%	13	0.73%	16	2.05%	16	20.93%	10	47.89%	5
339	Miscellaneous Manufacturing	16.0%	9	-5.0%	14	5.10%	10	11.83%	5	17.67%	6	5.65%	13	51.50%	3	24.25%	14
311,312	Food and Beverage and Tobacco Products	13.1%	11	-10.5%	15	6.40%	7	-6.09%	15	-1.76%	17	1.66%	17	12.24%	16	34.92%	9
313,314	Textile Mills and Textile Product Mills	-10.2%	16	4.6%	12	-15.07%	17	0.41%	11	26.58%	3	6.08%	12	7.89%	17	28.31%	13
323	Printing and Related Support Activities	-5.4%	15	4.3%	13	-13.00%	16	-5.00%	14	3.99%	13	7.22%	9	14.93%	15	17.58%	16
335	Electrical Equip., Appliance, and Component Mfg.	-1.7%	14	-19.4%	17	0.29%	12	-9.41%	16	3.69%	14	15.29%	3	39.76%	6	40.74%	7
322	Paper Manufacturing	-15.9%	18	-11.9%	16	-5.24%	15	0.22%	12	12.83%	10	7.72%	8	17.92%	11	20.16%	15
336	Transportation Equipment Manufacturing	2.4%	13	-72.2%	18	-0.55%	14	-18.37%	17	-15.87%	18	-3.52%	18	29.30%	9	10.35%	18
315,316	Apparel and Leather Products Manufacturing	-12.6%	17	13.7%	11	-28.40%	18	-25.60%	18	0.85%	15	23.12%	1	-15.48%	18	12.17%	17

Source: Bureau of the Census (revenues and profits); Bureau of Economic Analysis (value added, VA per worker, compensation); International Trade Commission (imports and exports).

"18" corresponds to the worst. The industries are presented in descending order of "average rank," which is the rank calculated by averaging the ranks of the performance metrics—revenues, profits, output, value added, and exports.

What immediately stands out from these data is the fact that the strong performance of U.S. manufacturing as a whole, described above, has been widely distributed among its component industries. In other words, the average strength of the sector has not been driven by the strong performance of just a few industries.

From the perspective of real manufacturing revenues, 2002 was the nadir of the overall manufacturing recession. Real revenues for the sector had fallen nearly 10 percent from record levels in 2000. By 2006, real revenues had jumped nearly 23 percent for manufacturing as a whole, eclipsing previous sales records achieved throughout the 1990s, to establish a new record high of nearly $5 trillion.

Contrary to assertions of the demise of manufacturing, 13 of 18 industries showed revenue gains between 2002 and 2006. Twelve of those 13 industries experienced double-digit percentage increases. Significantly, those gains do not reflect a one-time surge attributable to something aberrational. Out of the 13 industries experiencing revenue gains between 2002 and 2006, 12 experienced gains year-over-year, every year or every year but one, which suggests that revenue growth is an ongoing trend.[35]

The profit picture was similar. The nearly 50 percent increase in real operating profits between 2002 and 2006 was also widely distributed. Real profits also increased for 13 of 18 industries, and 11 of those 13 experienced double-digit percentage increases. Nine of those 13 had year-over-year profit increases in every year or every year but one. But, unlike revenues, which bottomed out in 2002, manufacturing operating profits hit their low in 2001, plunging 47 percent from record highs the previous year. From 2001 to 2006, operating profits for the sector as a whole increased by a whopping 94 percent.

As far as production goes, real manufacturing output, which hit a record in 2006, increased for 13 of 18 component industries, and real value-added increased for 12 of 18. All of the industries experiencing increased output had year-over-year output increases every year or every year but one.

As has been frequently noted, employment in the manufacturing sector has been declining for decades. After a pronounced 16 percent drop between 2000 and 2003, attrition rates returned to the longer-term, gradual rate of decline in 2004. All of the 3-digit manufacturing industries experienced job losses between 1998 and 2005 and between 2002 and 2005. But declining employment amid rising output reflects increasing productivity. Annual value added per worker increased from around $81,000 in 1998 to around $96,000 in 2005, an increase of 18 percent. Since the bottom of the recession in 2002, value added per worker has increased nearly 11 percent. All but two industries experienced increases in productivity over that period.

Although real wage growth has been sluggish throughout manufacturing, wages are only part of total compensation. In manufacturing in particular, the value of employee benefits tends to be higher than the average in the overall economy. Whereas real wage growth between 2002 and 2005 was 3.4 percent for manufacturing as a whole, real benefits growth was 13.6 percent. Total compensation thus increased by about 5.7 percent over the period.

Total compensation growth economywide was 4.1 percent over the period, a figure that was surpassed by 14 of 18 manufacturing industries. Only one manufacturing industry, transportation equipment manufacturers, experienced a decline in real compensation since 2002.

Impact of Trade

Given the findings of robust manufacturing health, the contention that trade is a cause of manufacturing decline is all but moot. Of course, some industries have not been doing as well as others. Has trade had a different impact with respect to those industries?

What is perhaps most surprising about the data, given the antitrade rhetoric so popular in Washington, is that export growth was evident

What immediately stands out is the fact that the strong performance of U.S. manufacturing as a whole has been widely distributed among its component industries.

for all but one of 18 industries. Double-digit percentage export growth between 2002 and 2006 was the case for 16 of 18 industries. Export growth has been an important part of manufacturing's strong revenue and profit growth.

It is also quite evidently not the case that industries that have experienced the largest increases in imports have performed the poorest. As Table 1 indicates, industries that experienced faster growth in imports generally fared better with respect to the crucial indicators of health. Seven of the top 10 industries in terms of import growth ranked in the top 10 in terms of performance ("Average Rank"). Four of the five industries experiencing the fastest growth in imports were among the top five performing industries (in terms of "Average Rank"). The best performing industry experienced the largest growth in imports; the second best performing industry experienced the second largest growth in imports. At the other end of the spectrum, four of the five industries with the slowest growth in imports were among the five worst performing industries.

These findings sharply contradict the conventional wisdom that seems to be informing the antitrade posturing of an increasing number of policymakers. Revenues, profits, output, value added, and even compensation rose the most for industries most exposed to import competition, and they rose the least for those industries experiencing the smallest increases in imports.

As a reality check on those findings about trade and manufacturing performance, Table 2 presents some basic correlation statistics to ascertain information about the relationship between trade, employment, wages, and operating performance.[36] The correlation statistic does not speak to the question of causality, but it does provide information about the relationship between variables. The figures in Table 2 can be interpreted as the slope of the line that plots the two variables being measured. A figure of 1.000 indicates a perfect positive linear relationship, such that the variables move in the same direction and by the same percentage. A -1.000 indicates a perfect negative linear relationship, such that the variables move in opposite direction by the same percentage.

What the data demonstrate is that for manufacturing as a whole, and for most industries, there is a stronger positive correlation between imports and exports, and between imports and revenues, and between imports and profits than there is a negative correlation between imports and employment, or between imports and wages.

- Out of 20 industries (including manufacturing overall), 15 demonstrated a stronger positive correlation between imports and exports than a negative correlation between imports and employment.
- Seventeen showed a stronger positive correlation between imports and exports than a negative correlation between imports and wages.
- Sixteen showed a stronger positive correlation between imports and revenues than a negative correlation between imports and wages.
- Thirteen industries even demonstrated a stronger correlation between imports and profits than between exports and profits.

Exposure to trade, as evidenced by the relationship between imports and exports and operating performance, has been an important component of the success of U.S. manufacturing industries.

On average, U.S. manufacturing is performing very well by historic standards. But that assessment does not characterize all U.S. manufacturing industries. Strong performance is eluding about one out of every three U.S. manufacturing industries (as defined at the 3-digit NAICS level). Within that third are a few industries that stand out as poor performers with respect to most of the performance-oriented metrics (revenues, profits, output, value-added) used to rank industries in Table 1. In particular, the paper industry (NAICS 322), apparel and leather products (315,316), printing (323), electrical equipment, appliance and component manufacturing (335), and transportation equipment manufacturing (336) have all experienced declines in three of the four performance-oriented metrics.

Exposure to trade has been an important component of the success of U.S. manufacturing industries.

Table 2
Correlation Coefficients

NAICS	Imports and Exports	Imports and Employment	Imports and Wages	Imports and Profits	Imports and Revenues	Exports and Employment	Exports and Wages	Exports and Profits	Exports and Revenues
MFG	0.908	-0.583	-0.075	0.814	0.966	-0.294	-0.408	0.749	0.929
311	0.393	-0.517	-0.736	0.593	0.927	0.074	-0.642	0.481	0.456
312	-0.453	0.038	-0.598	-0.291	-0.311	0.132	0.166	0.012	0.520
313,314	0.748	-0.906	-0.690	0.367	-0.402	-0.473	-0.540	0.566	0.136
315,316	-0.230	-0.352	0.358	0.854	0.142	0.966	-0.814	-0.361	0.668
321	0.576	0.017	-0.206	0.905	0.938	0.134	-0.637	0.407	0.547
322	0.885	-0.703	-0.538	0.139	-0.559	-0.633	-0.743	0.161	-0.562
323	0.712	-0.582	-0.389	0.514	-0.375	-0.126	-0.671	0.106	-0.107
324	0.886	-0.440	-0.733	0.879	0.954	-0.445	-0.844	0.817	0.886
325	0.973	-0.703	-0.161	0.425	0.846	-0.637	-0.203	0.386	0.875
326	0.886	-0.807	0.059	0.651	0.888	-0.471	-0.265	0.676	0.942
327	0.218	-0.114	-0.277	0.822	0.911	0.619	-0.625	0.264	0.315
331	0.941	-0.457	-0.487	0.964	0.980	-0.362	-0.589	0.876	0.964
332	0.890	-0.247	-0.169	0.696	0.874	0.125	-0.418	0.662	0.800
333	0.948	-0.286	-0.706	0.871	0.861	-0.003	-0.797	0.878	0.930
334	0.556	-0.094	0.743	0.619	0.692	0.604	-0.035	-0.028	0.886
335	0.895	-0.646	-0.032	-0.240	0.139	-0.325	-0.201	-0.017	0.170
336	0.820	-0.175	0.103	-0.233	0.761	0.041	-0.306	-0.296	0.631
337	0.723	-0.860	-0.180	0.543	0.595	-0.426	-0.516	0.661	0.815
339	0.727	-0.651	0.401	0.344	0.816	-0.782	0.257	0.249	0.903

Source: Author's calculations.

With the exception of the transportation equipment industry (which can attribute much of its bad performance to faulty production and labor-relations decisions), what these industries have in common is that they are relatively low-technology, low-wage, and labor-intensive. The skills required of workers in these industries and the going wage rates are generally below average for manufacturing. In effect, those are the industries that U.S. manufacturing is outgrowing as resources are reallocated to enterprises higher up the manufacturing value chain. In 1998, these industries accounted for over 12 percent of manufacturing output; in 2005, they accounted for only 8 percent. These are the industries in which the United States will and should have difficulty competing with manufacturers in lower-wage, lower-skill countries. The object of trade policy should not be to interfere with that process, particularly since it encourages workers to improve their skill sets and channels resources to where they can be used most efficiently.

Manufacturers' Own Words Confirm the Data

Although in stark contract to the picture of manufacturing decline presented by lobbyists and politicians in Washington, the findings presented above are not merely a competing thesis. They are the real story. And they are certainly not breaking news to the many manufacturing companies and industries whose tremendous success is reflected in those numbers. Even the most reputable and influential manufacturing trade associations have acknowledged that success and have distanced themselves from alarmist rhetoric about the manufacturing crisis.

At a congressional hearing on the topic of U.S.-China trade held earlier in 2007, Franklin

Vargo of the National Association of Manufacturers gave testimony that should be required reading for all lawmakers who are considering supporting trade legislation on behalf of manufacturing.

> It is not uncommon to hear that U.S. manufacturing is on its last legs, that we have been hollowed out and that our production base has moved overseas. A look at the factory shipments and industrial production data I have included as the last page of my testimony shows this is not true. Measured by historical standards and recent trends, U.S. manufacturing output is strong. This is not, of course, the case for all sectors. While some are doing very well, others are not. And within sectors some companies are doing well, while others are struggling to stay afloat.[37]

Vargo's testimony affirms many of the findings presented in the previous section. Other parts of his testimony seriously challenge the assertions of those who blame trade for the manufacturing sector's woes.

> Some commentators are fond of pointing out that the United States lost 3 million jobs in the "NAFTA-WTO decade." The clear implication is that NAFTA and trade generally are the cause of the 3 million job loss. But that is untrue.
>
> It is certainly true that between 2001 and 2003 nearly three million manufacturing jobs were lost—a huge number, close to one in every six jobs. The jobs have not come back since that time, with manufacturing employment trending down gradually since 2003. But since the U.S. manufactured goods deficit with NAFTA in 2001 was $38 billion and the 2006 manufactured goods deficit with NAFTA was also about $38 billion, how could the job loss have been caused by NAFTA? Since there was no increase in the manufactured goods deficit with NAFTA, it is hard to see what kind of analysis would indicate NAFTA as the cause of our job loss.[38]

Although some observers might infer (incorrectly) from Vargo's testimony that blaming trade for those job losses would be justifiable had the NAFTA deficit increased in 2006, the real thrust of that portion of his testimony is in its refutation of Lawrence Mishel's January 2007 testimony (cited above) that import growth was an important cause of the loss of those 3 million jobs.

According to statements and publications issued by manufacturing companies, industries, and their trade associations, manufacturers' chief concerns about the future of manufacturing include the rising costs of health care, energy, taxation, and regulation. The past three consecutive "Labor Day Reports," issued annually by the NAM, have identified these issues as primary concerns. In none of those issues was trade identified as something requiring the attention of policymakers.[39]

Despite all of the bluster about "saving" U.S. manufacturing, the truth is that the sector is in robust health.

Conclusion

The data presented above support three important conclusions: U.S. manufacturing is generally in superb health, and increasing international trade has a lot to do with that condition. Accordingly, lawmakers should back away from their hostile rhetoric about trade before they adopt policies that will damage the sector.

Despite all of the bluster about "saving" U.S. manufacturing, the truth is that the sector is in robust health. Record output, record sales, record profits, record returns on equity, and record compensation define the most recent year's performance. Rather than being aberrational, one-time blips, those records are all the latest data points of a gradually ascending trend line that has been evident since the beginning of the sector's recovery.

While some industries—mostly those that are more labor intensive and require lower-

skilled workers—have not been doing well in recent years, calls for interventionist trade policies are unjustified. Most of the five or six industries that are struggling are industries in which Americans have no comparative advantage. Measures to promote those industries would divert resources from the industries in which we are more competitive, discourage workers from acquiring new skills, and could inspire trade policy responses from abroad that would adversely affect our promising, competitive industries.

Instead of mischaracterizing the significance and meaning of the U.S. trade deficit and assuming that the loss of 3 million manufacturing jobs four years ago requires a tough response today, policymakers should try to attain a better understanding of the condition of U.S. manufacturing. They would learn that the sector is doing very well. And as Figure 6 and Tables 1 and 2 confirm, exposure to international trade has a lot to do with that performance. The evidence points to a U.S. manufacturing sector that is thriving in a global economy.

The evidence points to a U.S. manufacturing sector that is thriving in a global economy.

Appendix 1
Manufacturing Output and Value Added by Industry

		1998	1999	2000	2001	2002	2003	2004	2005	% Change 2002–05
Gross output ($ Millions)										
Manufacturing	**MFG**	$3,986,673	$4,064,662	$4,144,489	$3,805,050	$3,694,802	$3,719,232	$3,844,599	$3,992,959	8.07%
Food and beverage and tobacco products	311,312	$550,734	$550,252	$557,088	$557,903	$549,162	$563,363	$577,458	$584,289	6.40%
Textile mills and textile product mills	313,314	$91,387	$88,121	$84,491	$74,385	$71,612	$67,995	$65,249	$60,821	-15.07%
Apparel and leather and allied products	315,316	$74,960	$71,455	$66,370	$55,197	$44,369	$36,971	$32,006	$31,766	-28.40%
Wood products	321	$94,476	$99,599	$94,067	$84,867	$84,425	$84,936	$93,635	$93,143	10.33%
Paper products	322	$158,079	$158,258	$162,393	$150,024	$145,268	$139,165	$137,850	$137,655	-5.24%
Printing and related support activities	323	$103,008	$103,684	$103,410	$97,750	$91,338	$86,311	$84,675	$79,466	-13.00%
Petroleum and coal products	324	$139,574	$162,161	$230,354	$212,371	$203,922	$228,211	$281,688	$352,638	72.93%
Chemical products	325	$421,623	$420,034	$437,594	$414,992	$425,817	$445,725	$472,127	$478,323	12.33%
Plastics and rubber products	326	$167,650	$173,161	$174,616	$163,591	$162,664	$163,948	$163,358	$171,104	5.19%
Nonmetallic mineral products	327	$94,744	$96,784	$95,930	$91,112	$90,244	$90,094	$92,442	$99,152	9.87%
Primary metals	331	$172,074	$158,895	$154,955	$132,729	$132,979	$126,975	$160,793	$171,645	29.08%
Fabricated metal products	332	$259,198	$258,635	$263,911	$242,709	$232,964	$225,774	$231,106	$240,275	3.14%
Machinery	333	$278,852	$272,490	$281,596	$247,264	$230,238	$231,878	$237,240	$254,916	10.72%
Computer and electronic products	334	$443,426	$464,225	$500,763	$408,954	$337,707	$329,851	$330,215	$338,173	0.14%
Electrical equip., appliances, and components	335	$117,824	$117,409	$121,697	$107,321	$96,625	$91,307	$92,129	$96,904	0.29%
Transportation Equipment	336	$636,569	$683,242	$623,645	$580,251	$601,868	$613,269	$599,540	$598,577	-0.55%
Furniture and related products	337	$71,405	$73,322	$74,045	$68,939	$71,448	$69,140	$71,433	$75,729	5.99%
Miscellaneous manufacturing	339	$111,089	$112,932	$117,564	$114,689	$122,153	$124,317	$121,655	$128,382	5.10%
Value added ($ Millions)										
Manufacturing	**MFG**	$1,392,952	$1,403,024	$1,426,218	$1,309,867	$1,298,206	$1,277,455	$1,311,157	$1,341,540	3.34%
Food and beverage and tobacco products	311,312	$142,564	$156,912	$154,809	$163,209	$165,923	$157,825	$142,703	$155,816	-6.09%
Textile mills and textile product mills	313,314	$28,118	$27,016	$26,453	$22,180	$21,065	$21,715	$21,412	$21,151	0.41%
Apparel and leather and allied products	315,316	$27,001	$25,278	$25,052	$22,261	$20,071	$17,159	$15,608	$14,933	-25.60%
Wood products	321	$30,431	$32,626	$31,437	$30,579	$29,197	$30,169	$34,960	$34,556	18.36%
Paper products	322	$54,060	$55,330	$55,594	$47,798	$48,286	$47,280	$48,208	$48,392	0.22%
Printing and related support activities	323	$48,207	$49,233	$49,009	$45,769	$43,824	$42,524	$42,429	$41,631	-5.00%
Petroleum and coal products	324	$31,763	$22,887	$26,248	$32,593	$25,190	$36,790	$49,164	$56,289	123.46%
Chemical products	325	$158,966	$160,565	$157,057	$153,539	$167,346	$168,675	$181,341	$185,586	10.90%
Plastics and rubber products	326	$65,927	$67,540	$66,728	$61,919	$62,897	$60,177	$61,287	$60,020	-4.57%
Nonmetallic mineral products	327	$43,874	$46,086	$45,743	$43,810	$44,092	$42,416	$45,242	$47,288	7.25%
Primary metals	331	$51,228	$48,333	$48,193	$40,109	$40,255	$36,042	$49,602	$54,157	34.54%
Fabricated metal products	332	$116,823	$118,895	$121,686	$109,412	$103,081	$99,901	$108,209	$115,750	12.29%
Machinery	333	$115,545	$107,930	$109,296	$100,737	$92,641	$88,599	$95,360	$98,526	6.35%
Computer and electronic products	334	$171,726	$166,323	$185,563	$133,719	$119,156	$116,532	$118,369	$120,013	0.72%
Electrical equip., appliances, and components	335	$46,370	$49,246	$50,580	$48,040	$46,822	$45,865	$41,773	$42,417	-9.41%
Transportation Equipment	336	$178,462	$183,564	$182,544	$168,814	$180,937	$175,215	$160,377	$147,695	-18.37%
Furniture and related products	337	$30,164	$31,640	$32,712	$29,492	$29,811	$31,432	$33,506	$32,891	10.33%
Miscellaneous manufacturing	339	$51,725	$53,623	$57,515	$55,891	$57,613	$59,138	$61,608	$64,429	11.83%

Source: Bureau of Economic Analysis.

Appendix 2
Manufacturing Revenues and Profits by Industry

	NAICS	2001	2002	2003	2004	2005	2006	% Change 2002–06
Revenues ($ Millions)								
Total Manufacturing	**MFG**	$4,194,817	$4,065,078	$4,123,784	$4,476,802	$4,840,181	$4,979,777	22.5%
Food Manufacturing	311	$318,813	$320,688	$340,124	$373,291	$384,707	$389,661	21.5%
Beverage and Tobacco Product Manufacturing	312	$142,869	$133,962	$128,253	$125,947	$126,850	$124,699	-6.9%
Textile Mills and Textile Product Mills	313,314	$46,088	$46,535	$44,064	$45,139	$43,771	$41,772	-10.2%
Apparel and Leather Products Manufacturing	315,316	$90,214	$85,400	$77,957	$83,296	$79,430	$74,607	-12.6%
Wood Product Manufacturing	321	$59,032	$60,123	$58,677	$68,386	$70,560	$67,829	12.8%
Paper Manufacturing	322	$157,903	$146,661	$137,780	$143,759	$131,933	$123,286	-15.9%
Printing and Related Support Activities	323	$67,612	$66,653	$64,400	$61,599	$60,318	$63,043	-5.4%
Petroleum and Coal Products Manufacturing	324	$461,497	$455,714	$560,880	$672,578	$889,768	$902,097	98.0%
Chemical Manufacturing	325	$518,863	$506,342	$509,469	$527,437	$560,162	$602,044	18.9%
Plastic and Rubber Products Manufacturing	326	$123,838	$117,305	$116,401	$129,745	$142,985	$146,791	25.1%
Nonmetallic Mineral Product Manufacturing	327	$89,494	$83,315	$82,527	$89,760	$103,231	$113,949	36.8%
Primary Metal Manufacturing	331	$139,027	$128,168	$124,914	$154,912	$172,381	$203,448	58.7%
Fabricated Metal Product Manufacturing	332	$193,305	$193,617	$191,663	$207,594	$210,730	$219,473	13.4%
Machinery Manufacturing	333	$260,504	$243,283	$233,455	$259,869	$280,759	$302,928	24.5%
Computer and Electronic Product Manufacturing	334	$494,053	$424,269	$419,906	$463,506	$490,526	$502,132	18.4%
Electrical Equip., Appliance, and Component Mfg.	335	$175,943	$175,047	$171,017	$177,544	$174,358	$172,148	-1.7%
Transportation Equipment Manufacturing	336	$706,520	$722,201	$711,340	$735,134	$744,476	$739,661	2.4%
Furniture and Related Product Manufacturing	337	$56,762	$54,016	$50,705	$53,980	$61,414	$72,098	33.5%
Miscellaneous Manufacturing	339	$92,479	$101,779	$100,251	$103,327	$111,821	$118,112	16.0%
Operating Profits ($ Millions)								
Total Manufacturing	**MFG**	$181,973	$236,118	$225,231	$285,579	$316,798	$353,112	49.5%
Food Manufacturing	311	$20,927	$21,766	$21,851	$23,412	$23,745	$23,448	7.7%
Beverage and Tobacco Product Manufacturing	312	$22,391	$25,160	$20,684	$19,950	$20,625	$18,559	-26.2%
Textile Mills and Textile Product Mills	313,314	$1,999	$2,343	$1,541	$1,743	$2,363	$2,450	4.6%
Apparel and Leather Products Manufacturing	315,316	$4,969	$6,492	$5,887	$7,086	$7,072	$7,382	13.7%
Wood Product Manufacturing	321	$1,838	$2,482	$3,145	$5,739	$4,865	$4,253	71.3%
Paper Manufacturing	322	$9,548	$7,837	$6,128	$8,548	$9,457	$6,905	-11.9%
Printing and Related Support Activities	323	$3,467	$4,352	$4,212	$4,373	$4,098	$4,540	4.3%
Petroleum and Coal Products Manufacturing	324	$32,805	$12,163	$24,523	$40,702	$60,775	$67,184	452.4%
Chemical Manufacturing	325	$43,555	$51,554	$50,835	$43,170	$51,492	$66,340	28.7%
Plastic and Rubber Products Manufacturing	326	$5,370	$7,552	$6,362	$6,978	$8,078	$9,269	22.7%
Nonmetallic Mineral Product Manufacturing	327	$6,615	$5,999	$5,761	$7,306	$10,261	$11,728	95.5%
Primary Metal Manufacturing	331	$1,683	$2,737	$844	$12,596	$15,266	$20,993	666.9%
Fabricated Metal Product Manufacturing	332	$12,005	$12,875	$12,921	$16,550	$17,970	$20,803	61.6%
Machinery Manufacturing	333	$12,665	$11,687	$11,812	$17,973	$20,629	$26,059	123.0%
Computer and Electronic Product Manufacturing	334	-$33,084	$10,607	$13,914	$23,021	$26,798	$27,779	161.9%
Electrical Equip., Appliance, and Component Mfg.	335	$17,054	$17,594	$12,155	$11,492	$12,231	$14,189	-19.4%
Transportation Equipment Manufacturing	336	$8,201	$18,854	$10,671	$20,475	$3,605	$5,241	-72.2%
Furniture and Related Product Manufacturing	337	$3,170	$3,570	$2,959	$3,156	$4,523	$6,025	68.8%
Miscellaneous Manufacturing	339	$6,796	$10,492	$9,025	$11,308	$12,944	$9,963	-5.0%

Source: Bureau of the Census.

Appendix 3
Employment and Productivity by Industry

		1998	1999	2000	2001	2002	2003	2004	2005	% Change 2002–05
Full-time equivalent employees (1,000s)										
Manufacturing	**MFG**	17,225	17,045	16,947	16,190	15,056	14,306	14,117	14,044	-6.72%
Food and beverage and tobacco products	311,312	1,706	1,716	1,719	1,718	1,702	1,670	1,648	1,627	-4.41%
Textile mills and textile product mills	313,314	666	620	584	521	474	436	405	376	-20.68%
Apparel and leather and allied products	315,316	652	596	538	486	408	359	332	301	-26.23%
Wood products	321	597	618	606	576	566	544	556	564	-0.35%
Paper products	322	616	607	596	564	528	502	485	469	-11.17%
Printing and related support activities	323	774	775	767	764	705	675	663	644	-8.65%
Petroleum and coal products	324	129	126	120	118	116	114	109	109	-6.03%
Chemical products	325	966	967	968	946	913	891	872	862	-5.59%
Plastics and rubber products	326	938	935	942	880	835	806	793	791	-5.27%
Nonmetallic mineral products	327	531	535	545	535	511	492	495	496	-2.94%
Primary metals	331	625	609	611	560	498	467	458	459	-7.83%
Fabricated metal products	332	1,728	1,729	1,738	1,645	1,527	1,457	1,469	1,504	-1.51%
Machinery	333	1,479	1,433	1,420	1,348	1,209	1,136	1,125	1,148	-5.05%
Computer and electronic products	334	1,831	1,786	1,813	1,728	1,479	1,336	1,300	1,296	-12.37%
Electrical equipment, appliances, and components	335	565	552	568	548	491	455	440	429	-12.63%
Transportation Equipment	336	2,061	2,058	2,019	1,912	1,816	1,748	1,754	1,762	-2.97%
Furniture and related products	337	637	657	664	630	593	559	561	556	-6.24%
Miscellaneous manufacturing	339	725	727	728	711	685	662	650	651	-4.96%
Value Added per Worker										
Manufacturing	**MFG**	$80,868	$82,313	$84,158	$80,906	$86,225	$89,295	$92,878	$95,524	10.78%
Food and beverage and tobacco products	311,312	$83,566	$91,441	$90,058	$94,999	$97,487	$94,506	$86,591	$95,769	-1.76%
Textile mills and textile product mills	313,314	$42,219	$43,574	$45,296	$42,572	$44,440	$49,806	$52,869	$56,252	26.58%
Apparel and leather and allied products	315,316	$41,412	$42,413	$46,565	$45,805	$49,195	$47,797	$47,013	$49,611	0.85%
Wood products	321	$50,973	$52,792	$51,876	$53,088	$51,584	$55,459	$62,877	$61,270	18.78%
Paper products	322	$87,759	$91,153	$93,279	$84,748	$91,451	$94,183	$99,397	$103,181	12.83%
Printing and related support activities	323	$62,283	$63,526	$63,897	$59,907	$62,162	$62,998	$63,996	$64,645	3.99%
Petroleum and coal products	324	$246,222	$181,642	$218,733	$276,213	$217,153	$322,720	$451,049	$516,409	137.81%
Chemical products	325	$164,561	$166,045	$162,249	$162,303	$183,293	$189,309	$207,960	$215,297	17.46%
Plastics and rubber products	326	$70,285	$72,235	$70,837	$70,362	$75,325	$74,662	$77,285	$75,879	0.73%
Nonmetallic mineral products	327	$82,624	$86,141	$83,932	$81,887	$86,286	$86,211	$91,398	$95,338	10.49%
Primary metals	331	$81,964	$79,365	$78,876	$71,622	$80,834	$77,178	$108,301	$117,990	45.97%
Fabricated metal products	332	$67,606	$68,765	$70,015	$66,512	$67,505	$68,566	$73,662	$76,961	14.01%
Machinery	333	$78,124	$75,318	$76,969	$74,731	$76,626	$77,992	$84,765	$85,824	12.00%
Computer and electronic products	334	$93,788	$93,126	$102,351	$77,384	$80,565	$87,225	$91,053	$92,603	14.94%
Electrical equipment, appliances, and components	335	$82,070	$89,214	$89,049	$87,664	$95,360	$100,801	$94,939	$98,875	3.69%
Transportation Equipment	336	$86,590	$89,195	$90,413	$88,292	$99,635	$100,238	$91,435	$83,822	-15.87%
Furniture and related products	337	$47,354	$48,158	$49,265	$46,812	$50,272	$56,230	$59,725	$59,157	17.68%
Miscellaneous manufacturing	339	$71,345	$73,760	$79,004	$78,610	$84,107	$89,332	$94,782	$98,970	17.67%

Source: Bureau of Economic Analysis.

Appendix 4
Compensation in Manufacturing by Industry

		1998	1999	2000	2001	2002	2003	2004	2005	% Change 2002–05
Compensation ($ Millions)										
All industries		$43,678	$44,875	$46,407	$46,409	$47,248	$48,249	$48,888	$49,196	4.12%
Manufacturing	**MFG**	$49,665	$51,206	$54,219	$52,887	$55,734	$58,372	$58,385	$58,907	5.69%
Food and beverage and tobacco products	311,312	$39,434	$39,701	$41,510	$41,562	$44,338	$43,224	$43,817	$45,074	1.66%
Textile mills and textile product mills	313,314	$31,138	$32,590	$34,705	$34,882	$35,677	$35,854	$37,321	$37,847	6.08%
Apparel and leather and allied products	315,316	$28,514	$28,613	$30,227	$29,700	$31,319	$35,635	$36,708	$38,561	23.12%
Wood products	321	$35,254	$35,435	$36,587	$36,193	$36,408	$37,339	$38,291	$38,669	6.21%
Paper products	322	$52,189	$53,357	$54,680	$55,447	$59,734	$67,121	$63,829	$64,344	7.72%
Printing and related support activities	323	$44,283	$44,675	$46,027	$43,709	$44,549	$45,869	$46,555	$47,764	7.22%
Petroleum and coal products	324	$79,846	$77,850	$80,400	$82,245	$96,381	$89,534	$98,023	$107,689	11.73%
Chemical products	325	$69,913	$71,408	$74,479	$73,916	$82,165	$84,368	$87,244	$88,638	7.88%
Plastics and rubber products	326	$40,972	$41,465	$42,589	$42,506	$44,275	$44,622	$45,578	$45,184	2.05%
Nonmetallic mineral products	327	$44,114	$45,446	$47,317	$46,859	$47,860	$48,530	$49,031	$49,904	4.27%
Primary metals	331	$54,794	$56,317	$56,956	$56,219	$57,092	$58,433	$62,023	$61,877	8.38%
Fabricated metal products	332	$44,061	$44,324	$46,225	$45,918	$47,161	$47,721	$48,506	$48,407	2.64%
Machinery	333	$52,853	$53,872	$56,659	$54,594	$56,464	$58,853	$61,318	$60,474	7.10%
Computer and electronic products	334	$67,215	$73,835	$85,792	$77,602	$79,412	$84,211	$87,332	$88,600	11.57%
Electrical equip., appliances, and components	335	$48,499	$51,624	$53,931	$50,983	$53,973	$57,617	$59,480	$62,226	15.29%
Transportation Equipment	336	$62,479	$64,087	$65,573	$65,260	$73,694	$82,079	$71,425	$71,100	-3.52%
Furniture and related products	337	$33,513	$34,097	$35,825	$35,500	$36,335	$42,275	$45,897	$43,884	20.78%
Miscellaneous manufacturing	339	$44,934	$46,454	$48,503	$48,984	$50,749	$52,516	$53,916	$53,614	5.65%
Wages and Salaries ($ Millions)										
All industries		$36,404	$37,463	$38,762	$38,611	$38,643	$39,121	$39,537	$39,649	2.60%
Manufacturing	**MFG**	$40,577	$41,821	$44,216	$42,751	$43,058	$43,938	$44,533	$44,508	3.37%
Food and beverage and tobacco products	311,312	$32,388	$32,623	$34,119	$33,884	$34,080	$34,566	$34,426	$34,316	0.69%
Textile mills and textile product mills	313,314	$26,049	$27,237	$29,019	$28,839	$29,414	$29,307	$30,017	$29,827	1.40%
Apparel and leather and allied products	315,316	$23,694	$23,602	$24,788	$23,998	$25,285	$26,170	$27,159	$27,711	9.59%
Wood products	321	$29,376	$29,483	$30,376	$29,924	$29,798	$30,195	$30,811	$31,138	4.50%
Paper products	322	$43,622	$44,585	$45,579	$45,788	$46,552	$47,123	$46,945	$46,998	0.96%
Printing and related support activities	323	$37,575	$37,923	$38,949	$36,613	$36,842	$36,985	$37,135	$37,178	0.91%
Petroleum and coal products	324	$63,068	$60,869	$62,550	$63,376	$63,327	$64,556	$69,410	$73,268	15.70%
Chemical products	325	$57,460	$58,554	$60,934	$59,924	$60,241	$62,205	$63,578	$64,145	6.48%
Plastics and rubber products	326	$34,076	$34,464	$35,359	$34,959	$35,734	$36,104	$36,507	$35,867	0.37%
Nonmetallic mineral products	327	$36,312	$37,432	$38,873	$38,284	$38,815	$39,144	$39,291	$39,803	2.54%
Primary metals	331	$44,243	$45,462	$45,764	$44,717	$44,727	$45,540	$47,254	$46,742	4.51%
Fabricated metal products	332	$36,138	$36,262	$37,692	$37,283	$37,574	$37,916	$38,343	$38,151	1.53%
Machinery	333	$44,151	$44,787	$46,865	$44,944	$45,236	$46,007	$47,145	$47,029	3.96%
Computer and electronic products	334	$55,536	$61,147	$71,378	$63,981	$63,678	$66,416	$68,181	$69,141	8.58%
Electrical equip., appliances, and components	335	$38,618	$41,092	$42,759	$39,896	$40,357	$41,366	$42,720	$42,713	5.84%
Transportation Equipment	336	$48,550	$49,970	$50,793	$49,935	$51,637	$52,887	$52,637	$51,440	-0.38%
Furniture and related products	337	$27,759	$28,244	$29,643	$29,216	$29,571	$30,163	$30,214	$30,147	1.95%
Miscellaneous manufacturing	339	$35,681	$36,928	$38,490	$38,716	$39,319	$40,561	$41,744	$40,843	3.87%

Source: Bureau of Economic Analysis.

Notes

1. *Economic Report of the President* (Washington: Government Printing Office, 2007), Table B-46. Hereinafter ERP.

2. Ibid.

3. House Ways and Means Committee, "A New Trade Policy for America," March 27, 2004, http://waysandmeans.house.gov/media/pdf/NewTradePolicy.pdf (emphasis added).

4. Ibid.

5. Statement of The Honorable Pete Visclosky, Representative in Congress from the State of Indiana and Chairman of the Congressional Steel Caucus, Testimony Before the Subcommittee on Trade of the House Committee on Ways and Means, March 15, 2007 (emphasis in original), http://waysandmeans.house.gov/hearings.asp?formmode=detail&hearing=537.

6. Office of Sen. Debbie Stabenow, "Michigan Democrats Call for Comprehensive Initiative to Revitalize U.S. Manufacturing," press release May 17, 2007, http://www.senate.gov/~stabenow/press/2007/051707MichiganDemocrats.htm.

7. Office of Sen. Carl Levin, "The American Manufacturing Initiative," press release, May 25, 2007, http://levin.senate.gov/newsroom/release.cfm?id=275203.

8. Stabenow.

9. Bureau of Economic Analysis, Regional Economic Accounts, "Gross Domestic Product (GDP) by State, 2006," press release, June 7, 2007, http://www.bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm.

10. Statement of Duncan Hunter, Republican presidential candidate, Republican Candidates' Debate, Ronald Reagan Presidential Library, Simi Valley, California, May 3, 2007, http://www.nytimes.com/2007/05/03/us/politics/04transcript.html?ex=1181707200&en=afe7246a8e5b8b2f&ei=5070.

11. Statement of Dennis Kucinich, Democratic presidential candidate, Democratic Candidates' Debate, St. Anselm College, Manchester, New Hampshire, June 3, 2007, http://kerryfoxlive.com/wordpress/?p=8849.

12. *National Review Online*, http://hillaryspot.nationalreview.com/.

13. Statement of Lawrence Mishel, Ph.D., president, Economic Policy Institute, Testimony Before the House Committee on Ways and Means, January 30, 2007.

14. ERP, Table B-2.

15. Ibid.

16. ERP, Table B-36.

17. Compiled from ERP, Table B-42.

18. Numbers compiled from information found at www.thomas.loc.gov.

19. HR 294, http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h294ih.txt.pdf.

20. HR 1002, http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h1002ih.txt.pdf.

21. Unemployment data come from the Bureau of Labor Statistics; wage data come from ERP, Table B-47.

22. See, for example, Daniel Griswold, "A Package Deal: U.S. Manufacturing Imports and Output Rise and Fall Together," Cato Institute Free Trade Bulletin no.17, February 24, 2005.

23. Bureau of Economic Analysis, Survey of Current Business, Table F.1, U.S. International Transactions in Goods and Services, July 2007, vol. 87, no.7, http://www.bea.gov/scb/pdf/2007/07%20July/D-Pages/0707Dpg_F.pdf).

24. Patrick J. Buchanan, "Free Trade and Funny Math," *Human Events*, February 27, 2007.

25. UN Industrial Development Organization, "Share in Regional and World MVA," http://www.unido.org/data/coutnry/stats/, cited in Edward Gresser, "Healthy Factories, Anxious Workers," Progressive Policy Institute Policy Paper, February 2007, http://www.ppionline.org/documents/Healthy_Factories_020907.pdf.

26. U.S. Bureau of the Census, "Quarterly Financial Report for Manufacturing, Mining, and Trading Corporation," 1Q 1995–4Q 1996.

27. Ibid.

28. ERP, Table B-93.

29. Michael E. Porter, *The Competitive Advantage of Nations*, 1st ed. (New York: Free Press, 1990).

30. U.S. Department of Commerce, *Manufacturing in America*, p. 17, http://www.commerce.gov/opa/press/Secretary_Evans/2004_Releases/Manufacturing%20Report/DOC_MFG_Report_Complete.pdf.

31. Ibid.

32. Bureau of Economic Analysis, Industry Economic Accounts, Gross-Domestic-Product-by-Industry Data (1998–2006), http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1998-2006.xls.

33. In some government statistical presentations, NAICS codes are consolidated and, consequently, there are fewer than 21 classifications.

34. In Table 1, data are presented for only 18 industry groups because six industries were consolidated into three industries (311 was merged with 312; 313 with 314, and; 315 with 316). This was necessary to ensure uniformity of reporting (i.e., so that each industry grouping would have data reported for each metric in Table 1).

35. Please consult the appendices to see the underlying data and to follow the analysis about trends.

36. The results are based on 24 quarterly observations (1Q 2001–4Q 2006) for each variable.

37. Testimony of Franklin Vargo, vice president, International Economic Affairs, National Association of Manufacturers before the Trade subcommittee of the House Ways and Means Committee, "U.S.-China Trade and Economic Relations," February 15, 2007, p. 7.

38. Ibid.

39. National Association of Manufacturers, Labor Day Report 2004, 2005, 2006, http://www.nam.org/s_nam/bin.asp?CID=37&DID=235064&DOC=FILE.PDF.

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"Freeing the Farm: A Farm Bill for All Americans" by Sallie James and Daniel Griswold (no. 34; April 16, 2007)

"Leading the Way: How U.S. Trade Policy Can Overcome Doha's Failings" by Daniel Ikenson (no. 33; June 19, 2006)

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Executive Summary
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Changing Course on Navy Shipbuilding: Questions Congress Should Ask Before Funding

Mackenzie M. Eaglen

For more than a decade, the U.S. Navy has invested significant time and resources in designing a multipurpose destroyer, the DDG-1000 *Zumwalt*, to provide superior naval surface fire support, area anti-air warfare, and anti-submarine warfare (ASW) in the littorals.

However, during testimony on July 31, 2008, Navy leaders rescinded their support for the President's fiscal year (FY) 2009 budget request for a third DDG-1000 and advocated "truncating" the program. Navy officials insisted that the *Zumwalt* was no longer the best ship for the Navy due to a shifting security environment and a host of emerging weapons capabilities. Instead of procuring seven DDG-1000s, the Navy wants to purchase only three and to procure at least eight additional, upgraded DDG-51 *Arleigh Burke* destroyers.

In the FY 2009 defense appropriations bill, Congress has provided funding to keep both options open for the next Administration. Before making any major decisions about the future of the Navy's major surface combatant fleet in 2010, Congress needs to ask a series of questions that deserve straightforward answers from the Navy.

***Zumwalt* vs. *Arleigh Burke*.** The DDG-1000 and DDG-51 are both considered multimission destroyers because their different weapons systems make them more suited to different missions. The DDG-51 was designed during the Cold War to provide Aegis-based area air defense to aircraft carrier battle groups against Soviet naval bombers armed with anti-ship supersonic cruise missiles. The *Arleigh Burke* Flight IIA class carries two helicopters, and its sonar system is designed for littoral and open-ocean ASW operations.

The DDG-1000 is designed to conduct anti-submarine warfare operations in littoral waters, has a significantly smaller radar cross section, and can provide improved naval surface fire support for the Marine Corps. The DDG-1000 also offers the capability to support Special Operations Forces, a full range of rotary-wing aircraft, and a larger class of support boats. It will require 50 percent fewer personnel and generate 78 megawatts of electrical power, compared to the DDG-51's 7.5 megawatts.

These advanced capabilities explain why Chairman of the Joint Chiefs of Staff Admiral Michael Mullen said that the DDG-51 constitutes "moving…back to the 1980's technology."

Questions Congress Needs to Ask. Congress needs answers from the Navy to the following eight sets of questions, both to guide its oversight and to inform its funding decisions:

This paper, in its entirety, can be found at:
www.heritage.org/Research/NationalSecurity/bg2193.cfm

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- If the DDG-1000 cannot conduct area air defense, why is it classified as a guided missile destroyer? Could the DDG-1000 be upgraded to employ the Standard Missile? What are the growth potential and cost of the DDG-1000's Dual-Band Radar and combat management system for ballistic missile defense?
- What are the Marine Corps' specific naval surface fire-support requirements? Can they be met sufficiently without the planned seven DDG-1000s?
- Is the Navy's decision-making process being driven mostly by budget restraints or by changes in the threat assessment and requirements?
- If China's military capabilities are such a significant factor in the Navy's decision-making process, why did the Navy avoided discussing China in its recent Maritime Strategy?
- What are the growth potentials of *Zumwalt* and *Arleigh Burke* classes in terms of adding new systems, weapons (e.g., lasers), and combat capabilities?
- What are the design flaws, if any, in hull strength and/or weapon locations?
- What are the life cycle costs of adding new systems and combat capabilities?
- Has the projected timeline for procuring the CG(X), the next generation lead cruiser, slipped from 2011 to 2015 or later? If so, what is the Navy's specific plan for cruiser procurement, particularly in light of its concern about anti-ship cruise missiles and ballistic missiles?

The Burden Remains on the Navy's Leadership. During the long and somewhat turbulent history of the *Zumwalt* program, the Navy has continuously supported the ship while expanding its capabilities and reducing its numbers. After years of justifying its requirements, the Navy has reversed direction and is arguing that its future multimission destroyer is no longer the answer to the threats that the service may face in the future.

Recent testimony by Vice Admiral Barry McCullough and Deputy Assistant Secretary of the Navy for Ship Programs Allison Stiller has raised new questions and left other concerns unanswered. The Navy's leadership has an obligation to provide Congress with full answers to these questions in a timely manner. Before deciding which plan to fund in 2010, Congress should demand the information that it needs to conduct due diligence.

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Changing Course on Navy Shipbuilding: Questions Congress Should Ask Before Funding

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For more than a decade, the U.S. Navy has invested significant time and resources in designing a multipurpose destroyer, the DDG-1000 *Zumwalt*, to provide superior naval surface fire support, area anti-air warfare, and anti-submarine warfare (ASW) in the littorals.

However, during testimony on July 31, 2008, Navy leaders rescinded their support for the President's fiscal year (FY) 2009 budget request for a third DDG-1000 and advocated "truncating" the program. Navy officials insisted that the *Zumwalt* was no longer the best major surface combatant for the Navy due to a shifting security environment and a host of emerging weapons capabilities. Instead of procuring seven DDG-1000s, the Navy now seeks to purchase only three and to procure at least eight additional, upgraded DDG-51 *Arleigh Burke* destroyers.

The *Zumwalt* class and *Arleigh Burke* class are both considered multimission destroyers because their different weapons systems make them more suited to different missions. The DDG-51 was originally designed to provide Aegis-based area air defense to aircraft carrier battle groups against Soviet naval bombers armed with anti-ship supersonic cruise missiles. The latest version of the *Arleigh Burke* has a reduced radar cross section, and its sonar system is designed for littoral and open-ocean anti-submarine warfare operations. The *Zumwalt* class is designed to conduct anti-submarine warfare operations in littoral waters, has a significantly smaller radar cross section, and can provide improved naval surface fire support for the U.S. Marine Corps.

Talking Points

- After spending a decade designing and testing the DDG-1000 *Zumwalt* multimission destroyer and testifying to Congress that it was a "warfighting imperative" for the future fleet, Navy leaders have rescinded support for the destroyer.
- Navy officials now recommend that Congress limit *Zumwalt* procurement because of a changing threat environment that requires more "ballistic missile defenses, integrated air and missile defense, and antisubmarine warfare best provided by *Arleigh Burke* DDG-51s."
- The Navy's leadership needs to answer a series of outstanding questions in a timely manner before Congress decides which plan to fund in 2010.
- These questions include, among others, the ability of the *Zumwalt* to employ the Standard Missile, the naval surface fire-support requirements of the Marine Corps, the growth potential of both destroyers, and the Navy's plans for the CG(X) cruiser.

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In the FY 2009 defense appropriations bill, Congress has provided funding to keep both options open for the next Administration. Before making any major decisions about the future of the Navy's major surface combatant fleet in 2010, Congress needs to ask a series of questions that deserve straightforward answers from the Navy.

A Destroyer for the 21st Century

The U.S. Navy has spent more than a decade making the case for a new generation of major surface combatants. Today, it faces a changing security environment in which challenges range from non-state actors operating fast boats to emerging peer competitors that are deploying a new generation of diesel and nuclear-powered submarines. These challenges exist in the blue waters—the strategic naval battleground of the Cold War—and in the cluttered littorals of the Asia–Pacific and the Persian Gulf.

The result of this analysis, research, and development was the DDG-1000 *Zumwalt*-class destroyer. Originally designated as the DD-21 and then the DD(X), the DDG-1000 is a large multimission destroyer with a displacement of 14,987 tons.[1] It is outfitted with an advanced stealth design, a state-of-the-art Dual-Band Radar suite, a wave-piercing tumblehome hull, and a host of other technologies. With its advanced naval surface fire-support capabilities and anti-submarine warfare and anti-air warfare systems, the *Zumwalt* is well suited to land attack and littoral dominance.

However, the Navy's recent analysis of the altered threat environment and the capabilities required to defeat emerging threats—along with increasing budgetary pressures—caused Navy leaders to reverse course relatively rapidly in July. Officials advised Congress to abandon the *Zumwalt* program after the first two ships are constructed.

Primarily citing unforeseen threats in their argument to stop DDG-1000 procurement and to build upgraded *Arleigh Burke*-class destroyers, the Navy now asserts that the DDG-1000 is incapable of conducting both area defense anti-air warfare (versus point defense in which the ship defends itself with short-range surface-to-air missiles) and ballistic missile defense (BMD). New threats and the Navy's latest claim that the ship's naval fire-support capability can be replaced by aircraft launching precision bombs and by the U.S. Marine Corps' own fire-support assets have therefore eliminated the need for *Zumwalt*'s advanced naval artillery system.

After the Navy's reversal, the Office of the Secretary of Defense directed the Navy to build a third DDG-1000 in accordance with the President's FY 2009 defense budget request because procuring the ship "will provide stability of the industrial base and continue the development of advanced surface ship technologies such as radar systems, stealth, magnetic and acoustic quieting, and automated damage control."[2] However, after construction of the third *Zumwalt*, the Navy currently intends to order at least eight additional DDG-51 destroyers beginning in FY 2010.[3] Congress has left the door open to build either destroyer in FY 2010 because the Senate defense appropriations bill currently provides advance procurement funding for the fourth DDG-1000 and advance procurement funding for the DDG-51 program.

Congress will ultimately approve funding for major surface combatants to reach the goal of a 313-ship Navy. Before making a final decision to abandon the *Zumwalt* line and resume *Arleigh Burke* construction, Congress needs to ask a series of questions and receive honest and accurate answers from Navy officials. These questions center on the Navy's recent claims about a new threat matrix, the official rationale for discontinuing the *Zumwalt*, and what capabilities are needed to counter the emerging threats. Only after receiving the answers to these questions will Members of Congress have the necessary information to make a decision that will shape the fleet for the next 50 years.

1. Ronald O'Rourke, "Navy DD(X) and LCS Ship Acquisition Programs: Oversight Issues and Options for Congress," Congressional Research Service *Report for Congress*, updated October 28, 2004, pp. 9–10, at *http://digital.library.unt.edu/govdocs/crs//data/2004/upl-meta-crs-6395/RL32109_2004Oct28.pdf* (September 23, 2008).
2. Jerry Harkavy, "Navy to Seek Third DDG-1000," *Navy Times*, October 14, 2007, at *http://www.navytimes.com/news/2008/08/ap_ddg_1000_081808* (September 23, 2008).
3. Cassandra Newell, "USN Reinstates Third Zumwalt Destroyer," *Jane's Defence Weekly*, August 27, 2008, p. 8.

DDG-1000: A "Warfighting Imperative"

The origins of the DDG-1000 span more than a decade.

- In 1994 and 1995, the Navy initiated the DD-21 land-attack destroyer program with a plan to procure 32 ships.[4]
- By 2001, with costs continuing to rise, the Navy reclassified the ship as a multimission destroyer—the DD(X)—and reduced the planned procurement from 24 ships to 16 ships.
- On November 1, 2001, the program was again reclassified as a multimission guided-missile destroyer.
- After budget guidance from the Office of the Secretary of Defense in 2005, the Navy again downsized its procurement plan, with officials testifying to a requirement of eight to 12 ships.[5]
- Finally, in 2006, in conjunction with the Navy's announcement of its 313-ship plan, the program was renamed the DDG-1000 with a planned procurement of only seven ships.[6]

Navy officials have made the case for the DDG-1000 program on numerous occasions, but none was more dynamic than Chief of Naval Operations Admiral Vern Clark's testimony on July 19, 2005, before the Projection Forces Subcommittee of the House Armed Services Committee. Admiral Clark testified that the "DD(X) is the right ship to build now to meet Navy requirements in air, surface, and subsurface warfare, as well as also meeting U.S. Marine Corps and land combat fire support requirements ashore." The *Zumwalt* is "absolutely essential," a "U.S. Navy warfighting imperative," and "absolutely critical for its independent value in the global war on terror and the potential major conflicts [the United States] may face into the 2030 timeframe."[7]

During the same hearing, Assistant Secretary of the Navy for Research, Development, and Acquisition John Young and Rear Admiral Charles Hamilton, Program Executive Office for Ships, further articulated the Navy's case by arguing that the Navy needed the DDG-1000 because it provides multiple improvements over current capabilities, including a "10-fold improvement in battle-force defense, a 50-fold improvement in stealth, a 10-fold increase in operating area against shallow water mines, a three-fold increase in volume fire support for forces ashore, and a power system and architecture needed for future high-energy weapons."[8]

As recently as March of this year, the Navy continued to insist on the need for the DDG-1000 program. Vice Admiral Barry McCullough, Deputy Chief of Naval Operations, and Allison Stiller, Deputy Assistant Secretary of the Navy for Ship Programs, testified before the House Subcommittee on Seapower and Expeditionary Forces that the *Zumwalt* would "provide independent forward presence and deterrence and operate as an integral part of joint and combined forces."[9]

4. Ronald O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs: Background, Oversight Issues, and Options for Congress," Congressional Research Service *Report for Congress*, updated September 5, 2008.
5. Ronald O'Rourke, "Navy DD(X), CG(X), and LCS Ship Acquisition Programs: Oversight Issues and Options for Congress," *Congressional Research Service*, updated June 24, 2005, p. 17, at *http://digital.library.unt.edu/govdocs/crs//data/2005/upl-meta-crs-6753/RL32109_2005Jun24.pdf* (September 23, 2008).
6. Robert Work, "Know When to Hold 'Em, When to Fold 'Em: Thinking About Navy Plans for the Future Surface Battle Line," Center for Strategic and Budgetary Assessments, March 7, 2007, at *http://www.csbaonline.org/4Publications/PubLibrary/B.20070307._Know_When_to_Hold/B.20070307._Know_When_to_Hold.pdf* (September 23, 2008).
7. Admiral Vern Clark, "Plans and Programs for the DD(X) Next-Generation Multi-Mission Surface Combatant Ship," testimony before the Subcommittee on Projection Forces, Committee on Armed Services, U.S. House of Representatives, July 19, 2005, at *http://www.armedservices.house.gov/comdocs/schedules/CNO7-19-05.pdf* (September 23, 2008).
8. John J. Young, Jr., and Rear Admiral Charles S. Hamilton II, "Plans and Programs for the DD(X) Next-Generation Multi-Mission Surface Combatant Ship," testimony before the Subcommittee on Projection Forces, Committee on Armed Services, U.S. House of Representatives, July 19, 2005, at *http://www.armedservices.house.gov/comdocs/schedules/Young-Hamilton7-19-05.pdf* (September 23, 2008).
9. Vice Admiral Barry McCullough and Allison Stiller, "Navy Force Structure and Shipbuilding," statement before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, March 14, 2008, at *http://www.armedservices.house.gov/pdfs/SPEF031408/McCullough_Stiller_Testimony031408.pdf* (September 23, 2008).

A New Threat Environment

Yet in a relatively short time, Navy leaders have changed their assessment of the requirement for the DDG-1000, which they had argued was central to the future fleet. On July 31, 2008, Vice Admiral McCullough and Deputy Assistant Secretary Stiller again testified before the Subcommittee on Seapower and Expeditionary Forces, but this time they argued that the DDG-1000 program should be cancelled or "truncated" after the first two ships are built. Citing the need to "prioritize relevant combat capability" and "things that have happened in the near recent past that have significantly changed the way we view the threat," Admiral McCullough began by describing the Navy's new perception of the threat environment:

> Rapidly evolving traditional and asymmetric threats continue to pose increasing challenges to Combatant Commanders. State actors and non-state actors who, in the past, have only posed limited threats in the littoral are expanding their reach beyond their own shores with improved capabilities in blue water submarine operations, advanced anti-ship cruise missiles and ballistic missiles. A number of countries who historically have only possessed regional military capabilities are investing in their Navy to extend their reach and influence as they compete in global markets. Our Navy will need to outpace other Navies in the blue water ocean environment as they extend their reach. This will require us to continue to improve our blue water anti-submarine and anti-ballistic missile capabilities in order to counter improving anti-access strategies.[10]

He then detailed three changes in the threat environment that have forced the Navy to recalculate its needs:

> There are three specific areas. One is with the increased proliferation of ballistic missiles that provide anti-access challenges to our forces today globally, not only the high-end threat posed by potential adversaries in the Pacific, but lesser included capabilities in the Arabian Gulf region, in Northeast Asia, and the ability that that—or the proliferation into that threat globally.…
>
> The second piece is when you see high-tech threat capability that's usually resident in a nation state come off the beach in a conflict against a non-state actor and strike a warship and do significant damages to it, it's where is that capability going to go next, with what potential non-state actor. And that happened in the Eastern Med in 2006. And…there are nations that are developing quiet diesel submarine technology and putting it into blue water to challenge where we operate. And we need improved capability against the open-ocean deep water quiet diesel submarine threat.
>
> And that's where we see the capability that has come rapidly left from where it was projected. I don't think anybody ever envisioned Hezbollah being able to launch a C-802, and they did that quite well.[11]

Admiral McCullough then outlined why the DDG-1000 is no longer the best option for the U.S. Navy:

> [T]he DDG-1000 cannot perform area air defense; specifically, it cannot successfully employ the Standard Missile-2 (SM-2), SM-3, or SM-6 and is incapable of conducting Ballistic Missile Defense. Although superior in littoral ASW, the DDG-1000 lower power sonar design is less effective in the blue water than DDG-51 capability. DDG-1000's Advanced

10. Vice Admiral Barry McCullough and Allison Stiller, "Surface Combatant Requirements and Acquisition Structures," statement before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, July 31, 2008, p. 3, at *http://www.armedservices.house.gov/pdfs/SPEF073108/McCullough_Stiller_Testimony073108.pdf* (September 23, 2008).
11. Vice Admiral Barry McCullough, in hearing, *Navy Destroyer Acquisition Programs*, transcript from LexisNexis, Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, 110th Cong., 2nd Sess., July 31, 2008, p. 21.

> Gun System (AGS) design provides enhanced Naval Fires Support capability in the littorals with increased survivability. However, with the accelerated advancement of precision munitions and targeting, excess fires capacity already exists from tactical aviation and organic USMC fires.[12]

Finally, Admiral McCullough also noted that "[c]ombatant commanders continue to request more surface ships and increased naval presence to expand cooperation with new partners in Africa, the Black Sea, the Baltic region, and the Indian Ocean and maintain our relationships with our allies and friends."[13]

In this evolving threat environment, and recognizing that the DDG-1000 was incapable of meeting the Navy's new requirements, Admiral McCullough recommended that Congress instead fund additional DDG-51 *Arleigh Burke*-class destroyers. He testified that "[t]he demand from combatant commanders is for ballistic missile defenses, integrated air and missile defense, and antisubmarine warfare best provided by DDG 51s and not the surface fire support optimized in DDG 1000."[14]

Zumwalt vs. *Arleigh Burke*

There is a clear contradiction between what Navy leaders have previously stated about the operational value of the *Zumwalt* and what was said on July 31, 2008. A comparison of the combat systems and capabilities of the *Zumwalt* and *Arleigh Burke* provides a clearer picture of their relative strengths and weaknesses.

The DDG-1000 and DDG-51 are both considered multimission destroyers because their different weapons systems make them more suited to different missions. The DDG-51 was designed during the Cold War to provide Aegis-based area air defense to aircraft carrier battle groups against Soviet naval bombers armed with anti-ship supersonic cruise missiles.[15] The *Arleigh Burke* destroyers are armed with a single five-inch (127 mm) gun for surface fire support, and Flight IIA, the latest version of the DDG-51, has a vertical launching system with 96 cells. Further, the DDG-51 has stealth features that offer a reduced radar cross section compared to previous destroyer classes.[16] The *Arleigh Burke* Flight IIA class carries two helicopters, and its sonar system is designed for littoral and open-ocean ASW operations.

The DDG-1000 has two 155 mm Advanced Gun Systems that provide improved naval surface fire support and a vertical launching system of 80 cells. The DDG-1000's tumblehome hull and single-sloped superstructure—built partially of radar-absorbent materials—provide a significantly smaller radar cross section compared to other Navy vessels, making the DDG-1000 a stealthy ship.[17] The *Zumwalt* class is designed to carry up to two helicopters, or one helicopter and one unmanned aerial vehicle,[18] and to conduct anti-submarine warfare operations in littoral waters. The DDG-1000 offers the capability to support Special Operations Forces, a full range of rotary-wing aircraft, and a larger class of support boats. It will require 50 percent fewer personnel and generate 78 megawatts (MW) of electrical power, compared to the DDG-51's 7.5 MW. These advanced capabilities explain why Chairman of the Joint Chiefs of Staff Admiral Michael Mullen

12. McCullough and Stiller, "Surface Combatant Requirements and Acquisition Structures," p. 5.
13. *Ibid.*, p. 4.
14. McCullough, in hearing, *Navy Destroyer Acquisition Programs*, p. 5.
15. Norman Friedman, *U.S. Destroyers: An Illustrated Design History*, revised ed. (Annapolis: Md.: U.S. Naval Institute Press, 2004), pp. 391–392.
16. Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, 18th ed. (Annapolis, Md.: Naval Institute Press, 2005), p. 151.
17. Young and Hamilton, "Plans and Programs for the DD(X)"; Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*; and O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs."
18. Eric Wertheim, *The Naval Institute Guide to Combat Fleets of the World: Their Ships, Aircraft, and Systems*, 15th ed. (Annapolis, Md.: Naval Institute Press, 2007), p. 906, and Friedman, *U.S. Destroyers*, p. 449.

said that the DDG-51 constitutes "moving…back to the 1980's technology."[19]

Radar Systems and Area-Wide Anti-Air Warfare Capability. The DDG-51's main radar system is the SPY-1D passive phased-array radar, which is the main element of the Aegis combat management and fire-control system. DDG-51 Flight IIA is equipped with the SPY-1D(V) version of the radar, which is designed for littoral warfare to detect and engage small-sized sea-skimming anti-ship cruise missiles in clutter conditions caused by interference from coastal land or electronic jamming.[20] The SPY-1 radar of the *Ticonderoga*-class cruisers and the *Arleigh Burke* class can detect, identify, and track more than 200 contacts at an estimated range of up to 370 km.[21] SPY-1 can simultaneously track SM-2 missiles and their intended targets, directing the missiles through command guidance against up to 20 different targets.[22]

One limitation of Aegis is that it must illuminate each target with a dedicated target illuminator during the terminal phase of interception by an SM-2 missile.[23] The *Arleigh Burke* class has only three target illuminators, and the *Ticonderoga*-class has four. Thus, even though each target illuminator can quickly change to a new target after the previous target has been successfully intercepted, the *Arleigh Burke* can simultaneously engage only three targets. The SPY-1D(V) radar of the *Arleigh Burke* Flight IIA should be capable of guiding the new SM-6 missile.

The *Zumwalt* uses the advanced Dual-Band Radar suite, which is an integrated advanced radar system built around two active phased-array radar systems: the SPY-3 Multifunction Radar (MFR) and the S-band Volume Search Radar (VSR). The Dual-Band Radar suite greatly improves the ship's ability to track a range of signatures in both blue-water and cluttered littoral environments.[24]

The SPY-3 MFR is the DDG-1000's primary air-defense fire-control radar. It can perform area air defense to protect other ships in a naval task force and conduct short-range air defense. The SPY-3 is an X-band medium-range radar with a maximum range against air targets of about 150–167 km.[25] The SPY-3 will thus be able to engage "low-observable"[26] air targets, such as sea-skimming anti-ship cruise missiles,[27] unmanned aerial vehicles, and aircraft. Within the 150–167 km envelope, the SPY-3 will be able to fire and guide missiles to their targets, including the Evolved Sea Sparrow Missile, which has a range of 45 km,[28] and the SM-2 Block IIIB, which can engage sea-skimming cruise missiles at ranges of up to 167 km.[29] The Dual-Band Radar can

19. Admiral Mike Mullen, quoted in Ronald O'Rourke, "Navy DDG-1000 Destroyer Program: Background, Oversight Issues, and Options for Congress," Congressional Research Service *Report for Congress*, updated July 15, 2008, p. 2.
20. Norman Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, 5th ed. (Annapolis: Md.: U.S. Naval Institute Press, 2006), p. 317.
21. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 552; Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 316 and 597; and Duncan Lennox, ed., *Jane's Strategic Weapon Systems*, 48th ed. (Coulsdon, U.K.: Jane's Information Group, 2008), p. 356. The "volume-scan instrumented range" of the Aegis SPY-1 radar has been reported to be 324 kilometers (175 nautical miles). See Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 316.
22. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 553.
23. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 595.
24. O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs," updated September 5, 2008.
25. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 878.
26. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 317.
27. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 551, and Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 878.
28. Lennox, *Jane's Strategic Weapon Systems*, p. 354.
29. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 873, and Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 526.

illuminate targets and guide the SM-2 Block IIIB, but the *Zumwalt*'s combat direction system apparently must be modified to fire the SM-2.[30]

The S-band VSR provides effective long-range surveillance, detection, and tracking of air contacts up to 370 km.[31] It can detect, identify, and track over-the-horizon air and surface targets; conduct air traffic control duties of hundreds of air contacts; and "provide cuing for the SPY-3 MFR," sending target information to the SPY-3 radar.[32] The VSR, as it tracks both SM-2s and their intended air targets, could possibly give command guidance to Standard Missiles through flight updates via data link to the SM-2's inertial and command midcourse guidance system, like the Aegis SPY-1 radar. A senior Raytheon official seemed to confirm this assessment when talking about the *Zumwalt*'s combat management system: "Our [combat system] design has the SM-2 using the same link as used in all the other ships.... The Volume Search radar is essentially the same as the SPY-1D" Aegis radar used in all current DDGs and cruisers.[33]

With the necessary modifications, the DDG-1000's Dual-Band Radar could also guide the new SM-6 Extended Range Active Missile,[34] intended to replace the SM-2,[35] through command guidance flight updates sent directly to the SM-6 by the VSR.

Ballistic Missile Defense. The *Arleigh Burke*-class destroyers, particularly Flight IIA, were not designed to conduct ballistic missile defense. The BMD upgrades to the SPY-1D(V) radar were considered by the Ballistic Missile Defense Organization after it was developed for littoral waters operations against low-observable sea-skimming cruise missiles,[36] the same air defense role for which the DDG-1000's SPY-3 was originally designed.[37] There have also been plans to fit the Flight IIA destroyers with the more advanced SPY-1E active phased-array radar, which has greater ability to detect and engage ballistic missiles due to its greater sensitivity and ability to locate low-signature targets under clut-

30. U.S. Department of Defense, "R-1 Line Item No. 104: Exhibit R-2a, RDT&E Budget Item Justification," February 2007, p. 4, at *http://www.dtic.mil/descriptivesum/Y2008/Navy/0604366N.pdf* (September 23, 2008).
31. The VSR is based on Lockheed Martin's experimental SPY-2 radar, better known as the SPY-1E radar, an active phased-array radar designed to replace the SPY-1 radar of the *Ticonderoga*-class cruisers and *Arleigh Burke*-class destroyers. See Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 317 and 318, and Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 878.
32. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 552, and GlobalSecurity.org, "Volume Search Radar," April 27, 2005, at *http://www.globalsecurity.org/military/systems/ship/systems/vsr.htm* (September 23, 2008).
33. Dan Smith, quoted in Christopher P. Cavas, "Troubled DDG 1000 Faces Shipyard Problems," *Navy Times*, September 16, 2008, at *http://www.navytimes.com/news/2008/09/navy_zumwalt_091508w* (September 25, 2008).
34. The SM-6 Extended Range Active Missile (ERAM) is a version of the SM-2 that uses the active radar seeker from the Advanced Medium Range Air-to-Air Missile (AMRAAM). Using its active radar seeker, the missile guides itself to the air target in the terminal phase of interception without needing a fire-control radar to illuminate the target. The SM-6 has a reported maximum range of more than 350 km (probably 370 km) and is designed to shoot down supersonic anti-ship cruise missiles, aircraft, helicopters, unmanned aerial vehicles (UAVs), and cruise missiles flying overland beyond the ship's fire control radar. Through CEC and command guidance by the VSR, an SM-6 launched from a DDG-1000 could be directed toward a target, and the missile's active radar seeker would control the terminal phase of interception. A later version of the SM-6 will be able to engage short-range ballistic missiles (SRBMs). See Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 873; Lennox, *Jane's Strategic Weapon Systems*, p. 356; Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 597–598; and Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 512.
35. Christopher P. Cavas, "Will DDG-1000 Produce Any Ships at All?" *Defense News*, September 15, 2008, p. 8.
36. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 317.
37. GlobalSecurity.org, "AN/SPY-3 Multi-Function Radar (MFR)," April 27, 2005, at *http://www.globalsecurity.org/military/systems/ship/systems/mfr.htm* (September 23, 2008).

ter.[38] Reportedly, SPY-1 radars have tracked ballistic missiles at distances exceeding 1,000 km.[39]

The ballistic missile defense weapon of the Aegis system is the SM-3. It would seem that several of the *Arleigh Burke*-class destroyers are being upgraded for theater ballistic missile defense with the capability to fire the SM-3 and with BMD-capable upgraded versions of the Aegis weapon system like the Baseline 7 version.[40] The SM-3 Block 1 is designed to intercept short-range and medium-range ballistic missiles in midcourse. It has a GPS-assisted inertial navigation system and a range of approximately 1,200 km. Intercepts beyond 370 km would require using the network-centric warfare Cooperative Engagement Capability to receive targeting coordinates from other platforms.[41] The SM-3's fourth stage is the Lightweight Exoatmospheric Projectile Kinetic Warhead, which intercepts the ballistic missile.[42]

Sonar and the Anti-Submarine Warfare Mission. The two warships' anti-submarine warfare capabilities diverge along their main mission priorities. The DDG-1000's sonar system offers a more capable system for the littorals, while the DDG-51's works more effectively in blue waters. The *Arleigh Burke* Flight IIA is fitted with a very capable sonar suite for littoral and blue-water ASW operations. One component is the SQS-53C(V)1 hull-mounted sonar, which seems to be an adaptation of the original system designed to operate in both littoral waters and blue waters, as it is integrated with the Kingfisher high-frequency mine-avoidance sonar. The SQS-53C can reportedly detect targets at considerable ranges in shallow waters. Operating like a phased-array radar, the SQS-53C sonar can send out acoustic beams in different directions, allowing it to track multiple sonar contacts simultaneously. SQS-53C appears capable of reaching detection ranges in ocean waters of up to about 100 km (the second convergence zone).[43]

The DDG-1000's sonar suite consists of low-frequency bow sonar, the new Multi-Function Towed Array, the new Lightweight Broadband Variable Depth Sonar, and the dipping sonar of the destroyer's anti-submarine warfare helicopter.[44] The Lightweight Broadband Variable Depth Sonar, which functions at medium and high frequencies, is better suited to the acoustically cluttered littoral waters, particularly against slow submarines and sea mines in shallow waters. It has a limited detection range of about 28 km.[45] The Multi-Function Towed Array can operate at high, medium, and low frequencies.[46]

Yet the Navy has also been funding Tsunami, an alternative sonar suite for the DDG-1000. According to L3 Communications, Tsunami can replicate the performance of the *Arleigh Burke*'s SQS-53 bow sonar in blue waters, although it is claimed to operate more effectively in the littoral waters.[47] L3 claims that Tsunami is a "green sonar" because its

38. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 317; Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 553; and Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 908.
39. Lennox, *Jane's Strategic Weapon Systems*, pp. 359 and 360.
40. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 908, and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 597.
41. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 873; Lennox, *Jane's Strategic Weapon Systems*, pp. 359 and 360; and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 597.
42. Lennox, *Jane's Strategic Weapon Systems*, p. 359.
43. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 907; Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 147; and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 672.
44. Friedman, *U.S. Destroyers*, p. 448, and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 674.
45. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 674.; Anthony J. Watts, ed., *Jane's Underwater Warfare Systems 2004–2005*, 16th ed. (Coulsdon, U.K.: Jane's Information Group, 2004), p. 152; and Anthony J. Watts, ed., *Jane's Underwater Warfare Systems 2002–2003*, 14th ed. (Coulsdon, U.K.: Jane's Information Group, 2002), p. 141.
46. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 880.
47. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 677–678.

acoustic transmissions will not negatively affect marine life such as dolphins and whales.[48]

Tsunami's blue-water capability would apparently be complemented by the sonar suite's variable depth sonar, which seems to be derived from the Low-Frequency Active Towed Sonar. It can detect submarines beyond the first convergence zone (48 km).[49] This low-frequency active sonar technology was originally developed to detect very quiet Soviet submarines in blue waters at long distances using active pinging instead of passive detection. Used together, the DDG-1000's sonar suite and the towed array could triangulate and locate a submarine target faster than the *Arleigh Burke* Flight IIA class, which lacks a towed array.[50] However, the Navy's testimony on July 31 suggests that a towed-array sonar would likely be included in the follow-on DDG-51s that it plans to procure.[51]

Naval Surface Fire Support. The *Zumwalt* class will be equipped with a 155 mm Advanced Gun System, the most powerful and accurate long-range naval artillery system in the Navy. It can fire shells farther and faster (10–12 rounds per minute) and on different trajectories so that multiple shells strike a target simultaneously. An AGS shell can carry 24 pounds of explosives, compared to only eight pounds of explosives in a shell fired from the *Arleigh Burke*'s Mk 45.[52] The AGS can fire the GPS-guided Long Range Land Attack Projectile, which reportedly has a maximum range of approximately 60 nautical miles (111 km).[53] A single 155 mm AGS can replace an entire U.S. Marine Corps battery of 155 mm guns.[54] The Advanced Gun System can fire several types of munitions, including shells fitted with the anti-armor Sense and Destroy Armor submunition and an anti-ship warhead with a range of 30 nautical miles (55.5 km) against fast-moving vessels.[55]

In contrast, the DDG-51's single Mk 45, a single five-inch (127 mm) gun, has a maximum range of 23.7 km and fires smaller and less capable shells. Although it can fire 16–20 rounds per minute, it cannot fire precision-strike munitions, such as the Sense and Destroy Armor shells. The Extended Range Guided Munition, a long-range munition planned for the gun, was cancelled, leaving the gun system without a future long-range precision strike capability.[56]

Additional Capabilities. The state-of-the-art Advanced Integrated Electronic Warfare System, or SLY-2(V), which was being developed for Aegis cruisers and destroyers and the DDG-1000, was cancelled because of delays and cost overruns, leaving no alternative except for installing a modernized legacy system.[57] The Advanced Integrated Electronic Warfare System has an open architecture design that would assign and use the ship's countermeasures automatically after detecting, comparing,

48. Watts, *Jane's Underwater Warfare Systems 2004–2005*, p. 156.
49. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 678; Watts, *Jane's Underwater Warfare Systems 2004–2005*, pp. 153 and 156; and Watts, *Jane's Underwater Warfare Systems 2002–2003*, p. 142.
50. O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs," September 5, 2008.
51. *Ibid.*
52. *Ibid.*, p. 77.
53. *Ibid.* It has also been reported that the Long Range Land Attack Projectile would have a maximum range of 100 nautical miles (185 km) with a circular error probable (CEP) of 5–10 meters. See Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 875; Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 486; and E. R. Hooton, ed., *Jane's Naval Weapon Systems*, 40th ed. (Coulsdon, U.K.: Jane's Information Group, 2004), pp. 690–691.
54. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 875, and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 486.
55. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 491; Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 875; and Hooton, *Jane's Naval Weapon Systems*, p. 691.
56. It would have had a maximum range of 63 nautical miles (117 km) and a CEP of 10–20 meters. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 875.
57. *Ibid.*, p. 879, and Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 542.

and identifying sources of hostile electronic warfare emissions.[58] Without this system, the aging and soon-to-be-obsolete SLQ-32 Electronic Warfare system is being installed in the *Arleigh Burke* Flight IIA class, although, hopefully, the SLY-2(V) will be brought back given the absence of any advanced alternative to the Advanced Integrated Electronic Warfare System.[59]

Both the *Zumwalt* and *Arleigh Burke* Flight IIA classes lack a dedicated anti-ship missile capability. There is no provision in the DDG-1000 to mount the two quadruple launchers of the Harpoon anti-ship cruise missile. As a cost-saving measure, the *Arleigh Burke* Flight IIA class is not fitted with Harpoon missile launch canisters, but they could be mounted if needed.[60]

Questions Congress Needs to Ask

Both destroyers are incredibly capable ships and essential to the fleet. Given the decade-long research and development effort and the more than $10 billion investment in the DDG-1000, Congress should carefully examine the Navy's case for essentially halting the program after the third ship before deciding which class of major surface combatant to fund in the FY 2010 defense budget.

Specifically, Congress needs answers from the Navy to the following eight sets of questions, both to guide its oversight and to inform this significant funding decision.

QUESTION #1: If the DDG-1000 cannot conduct area air defense, why is it classified as a guided missile destroyer? Could the DDG-1000 be upgraded to employ the Standard Missile? What is the growth potential and cost of the DDG-1000's Dual-Band Radar and combat management system for ballistic missile defense?

Admiral McCullough testified on July 31 that the "DDG-1000 cannot perform area air defense, specifically, it cannot successfully employ the Standard Missile 2 (SM-2), SM-3, or SM-6 and is incapable of conducting Ballistic Missile Defense" and that "[m]odifying the DDG 1000s to support these [missile defense] missions is unaffordable, from the Navy's standpoint."[61] Considering the multimission guided-missile classification of the DDG-1000, this claim is suspect or not well explained. If the *Zumwalt* is incapable of deploying the SM-2, it should be classified as a general-purpose destroyer (DD), not a guided missile destroyer (DDG). However, not only did the Navy reclassify it as a DDG in 2001, but between 2002 and 2008, senior officials consistently included the SM-2 missile in their briefing slides, leading observers to conclude that the weapon would be included in the ship's arsenal.[62]

Additionally, according to a Raytheon spokesman, the "*Zumwalt* mission equipment was designed to accommodate the SM-2 family of missiles and is therefore easily scalable to accommodate the SM-3 and SM-6."[63] This appears to contradict Admiral McCullough's insistence that the DDG-1000 is a "ship which meets the requirements for which it was designed" but is incapable of performing area-wide anti-air warfare and ballistic missile defense.

While the Navy says that the DDG-1000 is unable to support the Standard Missile and that such an upgrade is unaffordable, officials are ignoring a spiral development program already underway that could make this feasible. Buried in the Navy's FY 2009 budget estimate is a Research, Development, Test and Evaluation program classified as "Standard Missile Improvement" that aims to "[d]efine DD(X) functionality/interface requirements and engineering changes needed to make

58. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 542.
59. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, pp. 908 and 879, and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 406.
60. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 908.
61. McCullough, in hearing, *Navy Destroyer Acquisition Programs*, p. 7.
62. O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs," September 5, 2008, p. 28.
63. "Defense Watch," *Defense Daily*, September 2, 2008, at *http://www.defensedaily.com/publications/dd/3811.html* (September 23, 2008; subscription required).

SM-2 [Block] IIIB compatible with the ship combat system."[64] According to the document:

> Development is expected to conclude by FY10 for the P3I [pre-planned product improvement] and SM-2 IIIB ICWI [Interrupted Continuous Wave Illumination]. Production representative missiles will be built between FY10 and FY12 for the 21 missiles that the DDG-1000 require for Developmental Test and Operational Test (DT&OT) in FY12 and FY13. SM2 IIIB will have dual use or AEGIS Cruisers/Destroyers and DDG-1000.[65]

This program received $7.7 million in funding in FY 2007 and $24.2 million in FY 2008.

Congress should seek clarification about the Navy's goals for this missile improvement program and whether or not the *Zumwalt* could support the Standard Missile.

QUESTION #2: What are the Marine Corps' specific naval surface fire-support requirements? Can they be met sufficiently without the planned seven DDG-1000s?

The Navy insists that it has both "excess capacity in naval surface fires that the DDG-1000 was predominately designed for" and "the capacity to support the Marine Corps' surface fires requirements."[66] Paul Francis of the Government Accountability Office (GAO) testified, "I was very much struck by Admiral McCullough's comment that the current fire support capabilities were sufficient to meet the need, yet three years ago that didn't appear to be the case, and that was the basis for the ship."[67] Although the *Zumwalt* is a multi-mission DDG, one of its primary missions—and thus principal justifications—was naval surface fire support.

After investing so much in this program, the Navy should document why this primary capability of the *Zumwalt* is not needed. If Admiral McCullough's statements are accurate, they must be further qualified by the Marine Corps' assessment of its naval surface fire-support requirements. A GAO report from 2006 described the Navy and Marine Corps' collaboration on naval surface fire-support requirements:

> Although the Marine Corps further defined its needs for naval surface fire support over the last 10 years, it only recently reached agreement with the Navy on a new set of requirements through the Joint Capabilities Integration and Development System, a joint process for establishing requirements. This process resulted in the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document*, which incorporated and validated the Marine Corps's requirements for naval surface fire support. These requirements are based on the concept of expeditionary operations that the service has been developing since 1992.[68]

The report also addressed how the DDG-1000's capabilities were incorporated into the naval surface fire-support mission: "Despite the new capabilities promised by the Extended Range Munition and *Zum-*

64. U.S. Department of the Navy, *Fiscal Year (FY) 2009 Budget Estimates: Justification of Estimates—Research, Development, Test and Evaluation, Navy Budget Activity 5*, February 2008, p. 416, at *http://www.finance.hq.navy.mil/FMB/09PRES/RDTEN_BA5_book.pdf* (September 23, 2008).

65. *Ibid.*, p. 417. While the DDG-1000's SPY-3 radar could be improved with ICWI technology, this might not be possible for the new Aegis SPY-1D(V) radar being fitted to the latest *Arleigh Burke* Flight IIA destroyers. ICWI is a missile guidance technology that is available for active phased-array radars such as the Dutch APAR. The APAR radar fitted with ICWI technology can illuminate 16 air contacts to guide Evolved Sea Sparrow Missiles and SM-2s simultaneously to their intended targets while guiding another 16 surface-to-air missiles to new targets through missile uplinks. Thus, it can simultaneously guide 32 missiles. See Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 493, and Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 265–266.

66. McCullough, in hearing, *Navy Destroyer Acquisition Programs*, p. 15.

67. Paul Francis, in hearing, *Navy Destroyer Acquisition Programs*, p. 30.

68. U.S. Government Accountability Office, *Defense Acquisitions: Challenges Remain in Developing Capabilities for Naval Surface Fire Support*, GAO–07–115, November 2006, p. 7, at *http://www.gao.gov/new.items/d07115.pdf* (September 23, 2008).

walt class destroyer, needs for naval surface fire support exceed projected capabilities."[69] The GAO's conclusion was based on the assumption that seven DDG-1000s would be built. Undoubtedly, its finding concerning needs and capabilities would be even more relevant if just two or three DDG-1000s are built.

During his testimony, Admiral McCullough revealed that "[t]he Navy–Marine Corps team has initiated an in-depth review to look at how surface fire capability fits into the littoral combat ship."[70] Recent reports indicate that the Office of the Secretary of Defense has directed the services to conduct a joint expeditionary fires analysis of alternatives before the Defense Acquisition Executive Review in June 2009.[71] The debate over the shape of the future surface combatant fleet must not be allowed to proceed without an understanding of the full findings of this study by Congress. Because the Navy and Marine Corps have often been at odds over naval surface fire-support requirements, no final decision should be made regarding DDG-1000 without first determining whether the two services are in fact in agreement on fire support.

QUESTION #3: Is the Navy's decision-making process being driven mostly by budget restraints or by changes in the threat assessment and requirements?

The Navy maintains that its decision is based on "the requirement and a threat" and that the DDG-1000 was not unaffordable, but rather that the resources needed to upgrade the ship to meet the requirements necessary for area-wide anti-air warfare and ballistic missile defense were unaffordable. However, Congress should consider the case of spiral development upgrades and conduct its own cost-benefit analysis.

For example, Congress has already funded a spiral development program for FY 2007 and FY 2008 that would allow the ship to be upgraded to fire the SM-2. Spiral development could also provide the necessary modifications to enable the DDG-1000 to fire the SM-3 for ballistic missile defense. A Raytheon spokesman confirmed that "in February 2008, a detailed technical paper was presented showing a clear path to the integration of the SM-3 missile into DDG-1000 with only minor changes due to the open architecture flexibility built into the DDG-1000."[72]

To analyze this question further, Congress needs to know whether the Marine Corps' leadership believes that the fire-support requirements are sufficient without the *Zumwalt*. If the Marine Corps maintains that eight to 12 ships (the number the Navy supported in testimony in 2005) are needed to meet its naval surface fire-support requirements, it would appear that budget considerations are driving the Navy's decision not to procure additional DDG-1000s.

Congress should learn exactly how much upgrading the *Zumwalt*'s capabilities would cost. The Navy has many competing priorities within its limited budget, but difficult decisions must be made. Congress will undoubtedly help to determine whether this is a financial opportunity worth pursuing.

QUESTION #4: If China's military capabilities are such a significant factor in the Navy's decision-making process, why did the Navy avoid discussing China in its recent Maritime Strategy?

It is appropriate and past time for Navy leaders to acknowledge in public testimony, plans, and strategies that the Chinese navy is rapidly modernizing into a force capable of seriously challenging the U.S. Navy in short-duration, high-intensity wars.[73] This

69. *Ibid.*, p. 3.
70. McCullough, in hearing, *Navy Destroyer Acquisition Programs*, p. 7.
71. Zachary M. Peterson, "Navy, Marine Corps to Study Naval Surface Fire Support Requirement Gaps," *Inside the Navy*, September 22, 2008.
72. O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs," September 5, 2008.
73. See James J. Shinn and Major General Phillip Breedlove, "China: Recent Security Developments," statement before the Committee on Armed Services, U.S. House of Representatives, June 25, 2008, at *http://armedservices.house.gov/pdfs/FC062508/Shinn_Breedlove_Testimony062508.pdf* (September 23, 2008), and Ronald O'Rourke, "China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress," Congressional Research Service *Report for Congress*, updated August 11, 2008, at *http://assets.opencrs.com/rpts/RL33153_20080811.pdf* (September 23, 2008).

is especially true given Chinese efforts to build a force capable of temporarily denying U.S. conventional forces access to key areas.[74]

The Office of the Secretary of Defense has recognized this, both in the 2006 *Quadrennial Defense Review* and in various annual reports to Congress on the military power of the People's Republic of China.[75] Why, then, has the Navy—the service at the forefront of U.S. efforts to hedge against China's rise—been unwilling to discuss the growing military competition from China publicly?

QUESTION #5: What are the growth potentials of the *Zumwalt* and *Arleigh Burke* classes in terms of adding new systems, weapons (e.g., lasers), and combat capabilities?

A ship's growth potential is often a function of the volume available, weight-carrying capacity, center of gravity (and stability), and the power-generation capacity of the propulsion system. Congress should conduct its own independent comparison of both ship classes when deciding which ship is most needed for the future fleet.

The *Arleigh Burke*-class destroyers and *Ticonderoga*-class cruisers suffer from a significant growth hindrance: limited space.[76] The DDG-51 gas turbines are linked to the propeller shafts, which occupy valuable space below deck. The DDG-1000's all-electric drive and Integrated Power System generates and distributes electricity more efficiently throughout the ship. Its gas turbines are linked directly to a power generator, which is linked by cable to a motor. The use of cables to distribute power takes less space, and the gas turbines do not need to be aligned with the propeller shafts.[77]

Furthermore, installation of the new SPY-1E radar could affect the stability of the upgraded *Arleigh Burke*s because the radar's phased-array panels weigh more than the panels of the earlier SPY-1 radar, which it will replace. While the SPY-1E's weight is concentrated more in the panels, freeing more space below deck,[78] this greater weight would be added to the ship's superstructure. Combined with the DDG-51's relatively narrow hull width and short length, this could cause stability problems, particularly when sailing in rough weather.[79]

In turn, the DDG-1000 design's longer and broader hull may provide better performance at certain speeds, reduced seaway resistance, and less fuel consumption.[80] Because of its larger size and volume capacity, the *Zumwalt* class could potentially accommodate more systems without compromising the ship's stability.

The DDG-1000 can generate more electrical power (78 MW)[81] than the DDG-51, which would enable it to power cutting-edge weapons systems such as lasers and rail guns. The *Arleigh Burke* lacks this capability because of its limited power-generation capacity. In terms of growth potential for ballistic missile defense and for anti-air defense, the DDG-1000 has no equal in the fleet. The DDG-

74. Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, and Kevin L. Pollpeter, *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United* States, RAND Corporation, 2007, p. 18, at *http://www.rand.org/pubs/monographs/2007/RAND_MG524.pdf* (September 23, 2008).
75. See U.S. Department of Defense, *Quadrennial Defense Review Report*, February 6, 2006, at *http://www.defenselink.mil/qdr/report/Report20060203.pdf* (September 23, 2008), and *Military Power of the People's Republic of China 2008*, March 2008, at *http://www.defenselink.mil/pubs/pdfs/China_Military_Report_08.pdf* (September 23, 2008).
76. Friedman, *U.S. Destroyers*, pp. 396, 424–425, and 447.
77. Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 145.
78. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, p. 317.
79. Design stability problems with the *Arleigh Burke* Flight IIA-class that resulted from adding more systems and weight required applying corrective measures to the USS *Pinckney* (DDG-91) and its follow-on sister ships. On each destroyer, 50 tons of ballast was added to port to compensate for the helicopter hangar and two WLD-1(V)1 mine-hunting vehicles and hoist installed on the starboard side. See Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 907.
80. Friedman, *U.S. Destroyers*, p. 426, and P. J. Gates, *Surface Warships: An Introduction to Design Principles* (London: Brassey's Defence Publishers, 1987), p. 55.
81. Wertheim, *The Naval Institute Guide to Combat Fleets of the World*, p. 906.

1000's power-generation capacity is more than adequate to power a solid-state laser weapon system for ballistic missile defense.

In the future, one of the *Zumwalt*'s two Advanced Gun Systems could be replaced with a solid-state laser weapon to shoot down ballistic missiles and air threats such as cruise missiles. In contrast to the SM-3 missile, a solid-state laser could intercept[82] several anti-ship maneuverable ballistic missile warheads attacking simultaneously.[83] Moreover, the Navy's experimental Sea Lite Beam Director laser has demonstrated that a laser weapon can function as a ballistic missile defense and air defense sensor to "passively track and image missiles in flight."[84]

A laser weapon mounted on the DDG-1000 could revolutionize ballistic missile defense and air defense warfare by providing immediate (at the speed of light) and accurate interception of targets and precise tracking and imaging of ballistic missiles and air contacts. The operational qualities of a laser weapon in the *Zumwalt* destroyers would complement the ballistic missile defense and air defense capabilities of the Aegis cruisers and destroyers well into the 21st century.

In addition to its growth potential in accommodating electromagnetic rail guns and laser weapons, the DDG-1000's Mk 57 Peripheral Vertical Launch System was designed to accommodate future land-attack and SAM missiles larger and wider than the current Tomahawk and Standard Missiles. A single cell of the Mk 57 launch system could also carry four Standard Missiles in a quad-pack due to the cell's greater size (28 inches wide).[85] This is a design capability that the *Arleigh Burke*'s Mk 41 vertical launching system does not have.

QUESTION #6: What are the design flaws, if any, in hull strength and/or weapons locations?

Congress should ask the Navy whether the *Arleigh Burke*'s hull stress problems, which have led to structural damage,[86] can be remedied with simple, small changes in the ship's design, or whether it is a design flaw that would inevitably appear after intense use.

Congress should also seek to learn how much it will cost to fix these problems throughout the life cycle of the DDG-51s. Congress has received conflicting data between 2005 and 2008 that have created confusion about the true operating and support costs, particularly if the DDG-51 operating and support costs are modified with future changes in this ship. Conversely, Congress should ask whether the DDG-1000's Peripheral Vertical Launch System is a potential death sentence for the ship if any of the missile cells, installed alongside the hull of the destroyer instead of in a central main battery as in the *Arleigh Burke*, is hit by an enemy supersonic sea-skimming anti-ship cruise missile. Also, in light of the Navy's argument that the *Arleigh Burke*s are better suited for ballistic missile defense, Congress should ask if the Mk 41 VLS central mis-

82. William Matthews, "Weapon of the Future: After Decades, Laser Technology Supporters Say Future Is About to Arrive," *Defense News*, September 15, 2008, p. 24.

83. BMD versions of the Standard Missile (SM-3 and SM-6) may not be able to guarantee interception of the new types of anti-ship maneuverable reentry vehicles (RVs), such as RVs from Chinese DF-21B (CSS-5), DF-21C, and DF-15B (CSS-6) intermediate-range ballistic missiles; RVs from the Russian SS-26 SRBM, which can maneuver at 30 g in the terminal phase; and the RV from the Russian SS-21 SRBM, which can maneuver at 10 g in its terminal phase. See Lennox, *Jane's Strategic Weapon Systems*, pp. 25, 24, 123, and 140. See also Christopher P. Cavas, "Missile Threat Helped Drive DDG Cut," *Defense News*, August 4, 2008, p. 8, and Wendell Minnick, "China Seeks Anti-Ship Ballistic Missile," *Defense News*, September 15, 2008, p. 16.

84. "The inherently precise pointing of the [Sea Lite Beam Director laser] and its ability to track very high speed targets make it an ideal platform for capturing in-flight imagery." The laser was reportedly used "as a sensor platform for tracking and imaging" several theater missile defense missiles in tests. Federation of American Scientists, "Mid-Infrared Advanced Chemical Laser (MIRACL)," updated March 21, 1998, at *http://www.fas.org/spp/military/program/asat/miracl.htm* (September 23, 2008).

85. Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, pp. 601, 600; Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 145.

86. "Report: DDG-51 Class Buckling Under Stress," *Navy Times*, October 14, 2007, at *http://www.navytimes.com/news/2007/10/navy_ddgs_buckling_071011w* (September 23, 2008).

sile battery of this class is the best design option when facing anti-ship ballistic missiles that could target the missile battery with electro-optic seekers, which could cause, if hit, the mass destruction of all its missiles and the loss of the ship.[87]

QUESTION #7: What are the life-cycle costs of adding new systems and combat capabilities?

Congress should ask what the potential operating and support costs would be for a further modified DDG-51 compared to the DDG-1000. If the Navy chooses to purchase the DDG-51 Flight IIA design, its estimated life-cycle operating and support costs, including maintenance and manpower, would exceed the DDG-1000's costs by $3.9 million annually.

However, it has also been suggested that a modified version of the *Arleigh Burke* could achieve substantial cost savings through further crew reductions, addition of electric-drive equipment, and installation of a near-surface bow bulb, which would reduce fuel consumption by nearly 4 percent. This could reduce the *Arleigh Burke*'s annual operating and support costs by as much as $2.5 million below the *Zumwalt*'s costs.

QUESTION #8: Has the projected timeline for procuring the CG(X), the next generation lead cruiser, slipped from 2011 to 2015 or even later? If so, what is the Navy's specific plan for cruiser procurement, particularly in light of its concern about anti-ship cruise missiles and ballistic missiles?

The Navy had planned to purchase the first CG(X) in 2011, but a recent report indicates that this date may slip to around 2017.[88] There have been some indications that the DDG-1000 hull, originally planned to be the basis of the CG(X) design, was not optimal to support either the CG(X)'s radar suite or a smaller version of the CVN-78 *Ford*-class nuclear reactor.[89]

These unanticipated design constraints may be a leading reason why the CG(X) procurement date has slipped, but the Navy's secrecy about the future cruiser program has left most observers unclear about the state of the program.[90] If the CG(X) is indeed the next-generation cruiser that can meet the new and emerging anti-air warfare and ballistic missile defense requirements, more clarity for Congress on the direction and timeline of the CG(X) program is warranted, even if additional DDG-51s are needed to fill the projected capabilities gap in the coming years.

The Burden Remains on the Navy's Leadership

During the long and somewhat turbulent history of the *Zumwalt* program, the Navy has continuously supported the ship while expanding its capabilities and reducing its numbers. After years of justifying its requirements, the Navy has reversed direction and is arguing that its future multimission destroyer is no longer the answer to the threats the service may face in the future.

The recent testimony by Admiral McCullough and Deputy Assistant Secretary Stiller has raised new questions and left other concerns unanswered. The Navy's leadership has an obligation to provide Congress with full answers to these questions in a timely manner. Before deciding which plan to fund in 2010, Congress should demand the appropriate information to conduct its due diligence.

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87. See Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, p. 145; Lennox, *Jane's Strategic Weapon Systems*, p. 122.
88. Katherine McIntire Peters, "Navy's Top Officer Sees Lessons in Shipbuilding Program Failures," *Government Executive*, September 24, 2008, at *http://www.govexec.com/story_page.cfm?articleid=41049&dcn=todays_most_popular* (September 29, 2008).
89. O'Rourke, "Navy DDG-1000 and DDG-51 Destroyer Programs," p. 14.
90. Christopher P. Cavas, "U.S. Navy CG(X) Off-Limits at Conference," *Defense News*, June 23, 2008, at *http://www.defensenews.com/story.php?i=3595373* (September 23, 2008).

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SOS: Congress Must Save the Aircraft Carrier Fleet

Mackenzie M. Eaglen and Jim Dolbow

Recently, U.S. Navy leadership sent a proposal to Congress requesting waiver authority to temporarily reduce its current fleet of 11 aircraft carriers to 10 from 2012 through 2015. Congress already approved, after much deliberation, the Navy's request to reduce the fleet from 12 to 11, which resulted in the decommissioning of the John F. Kennedy (CV-67) in 2007.

Congress should reject the Navy's latest request. Today's record-low carrier force level is already a substantial reduction from the level achieved by the Reagan Administration's military buildup in the 1980s, when the Navy had set the minimum number of carriers needed to secure the high seas at 15. Congress should continue its robust support of shipbuilding and seek again to increase the shipbuilding account in this year's defense bills.

"Quantity Has a Quality All Its Own." In 2006, Navy leaders presented a report to Congress that proposed a fleet of 313 ships, which included 11 aircraft carriers, 48 attack submarines, 88 cruisers and destroyers, 55 littoral combat ships, 31 amphibious ships, and a Maritime Prepositioning Force squadron with 12 new-construction amphibious and sealift-type ships.[1] Rebuilding a fleet that has shrunk by more than 50 percent over the past 15 years to 280 deployable ships today must remain a high priority of Navy leaders.

Unfortunately, the Navy finds itself in a not-unexpected predicament because of a 33-month gap between the decommissioning of the USS *Enterprise* (CVN-65) in November 2012 and the September 2015 commissioning of the Big E's replacement, the USS *Gerald R. Ford* (CVN-78). After a stellar 51-year career, the *Enterprise*'s nuclear reactors will be spent dry in November 2012. Ironically, the Navy has been aware of this coming train wreck (and did nothing to mitigate it throughout this past decade) ever since leaders briefed Congress at the beginning of the millennium on future carrier force levels.

All but absent in the discussion about the Navy's inventory of aircraft carriers is the fact that over the course of the past decade—and for several more decades to follow—one *Nimitz*-class aircraft carrier will be undergoing a lengthy Refueling and Complex Overhaul (RCOH) at all times. A carrier undergoing an overhaul of this complexity is, for all practical purposes, not efficiently or quickly deployable. In essence, the Navy is already at a backdoor level of 10 aircraft carriers and would trend downward to nine if the Navy gets its way with Congress.

Congress must ask whether nine aircraft carriers spread thin between the global areas of responsibility of five different regional Combatant Commanders is an acceptable level of risk. The question must acknowledge that the next engagement of naval forces could involve a nation-state or a non-state actor. Congress should carefully examine whether the Navy currently has enough carriers to meet the

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service's global commitments. If the Navy has any difficulty meeting combatant commander requirements today, it is inevitable that a trade-off would have to occur in the event that not enough carriers are available upon request during unforeseen circumstances. The question then becomes: How can the nation *not* afford to maintain a minimum fleet of 11 aircraft carriers?

Margin of Risk Is Too High. The United States is a maritime nation, and the Navy, Marine Corps, and Coast Guard are the primary guardians of this global status. The Navy's core competencies are to maintain maritime superiority on, below, and above the high seas against all powers, including nation-states and non-state actors. If the Navy is to continue to secure the high seas around the globe long into the 21st century, it needs a robust fleet, both in the quantity of ships and in the quality of its capabilities and technologies.

Congress should reject the Navy's waiver request and instead force the Navy to come up with a plan to eliminate the carrier shortfall in 2012. If Congress is serious about the United States Navy maintaining the capability to project firepower for freedom around the globe and not following the path of the Royal Navy, it should not approve this inherently risky gamble. One option for Congress to consider is to accelerate delivery of the USS *Gerald R. Ford* by increasing the Navy's shipbuilding account in order to place the construction of the *Ford* on a wartime footing. For example, extra workers could be hired to work three shifts a day, not to mention weekends and holidays.

Congress must hold Navy leaders' feet to the fire in order to ensure that the goal of a 12-carrier fleet is achieved by 2019 (or sooner if possible). Given the Navy's tendencies and zeal to retire ships early—ships like *Ticonderoga*-class cruisers and *Los Angeles*-class attack submarines—Congress should enact into law an additional requirement that all *Nimitz*-class carriers be refueled. This requirement would preempt officials at the Office of Management and Budget from eyeing the elimination of RCOHs for purposes of imaginary budgetary savings. Furthermore, the Navy must resist cannibalizing shipbuilding funds for other more urgent priorities if the 313-ship fleet is ever to become a reality.

Overall, preserving the shipbuilding program will likely require Congress to continue to increase the Navy's procurement budget as it has loyally done so many times over the last several years. There is little as powerful in the military inventory as 4.5 acres of sovereign U.S. territory that is used to counter and deter threats. In addition to the traditional carrier strike missions, CVNs could be used for expeditionary sea-based platforms for soldiers and marines.

Conclusion. Congress should not "go wobbly" on the Navy's request for a waiver from the requirement in 10 USC §5062 that it maintain an aircraft carrier force of at least 11 operational ships. Financing the future Navy fleet is a common-sense necessity for a maritime power.

A robust shipbuilding budget for the next 10 to 20 years is necessary in order to reverse the decline in the number of ships in the Navy's inventory. Failure in this regard will only embolden U.S. adversaries. The carrier shortfall is another perilous reminder that the defense budget topline is too low for the U.S. military to simultaneously field trained and ready forces, support ongoing operations, and modernize. Congress should commit now to spending 4 percent of gross domestic product (GDP) on national defense in part to meet the military's immediate modernization needs, including its carrier fleet.

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1. Ronald O'Rourke, "Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress," Congressional Research Service *Report for Congress*, updated June 12, 2007, p. 5.

Executive Summary
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Providing for the Common Defense: What 10 Years of Progress Would Look Like

James Jay Carafano, Ph.D., Baker Spring, and Mackenzie M. Eaglen

If the President and Congress make the right decisions over the next 10 years, America will have the optimal military to keep the nation safe, free, and prosperous while responding to the emerging national security challenges of the 21st century. Achieving the ideal mix of U.S. military forces will require building a robust complement of capabilities for the spectrum of missions the armed forces will face, ensuring adequate funding for ongoing operations, maintaining a trained and ready all-volunteer force, preparing for the future, and fundamentally reforming manpower and procurement policies.

To realize these goals, both the President and Congress must commit to a program that addresses the most pressing priorities: preparing, fielding, and sustaining the force.

Preparing the Force. To field the right force for the future, the Pentagon must change how it manages manpower costs and how it acquires goods and services.

The success of the all-volunteer military depends on a well-designed compensation package that attracts highly qualified people to military service. Above all, the compensation should be flexible and should favor cash and defined-contribution plans for health care and retirement. With the private sector conducting most scientific research and development, the Defense Department will need to become more adept at leveraging the private sector's capacity to provide the military with cutting-edge technology.

Fielding the Force. Rebalancing the defense budget and establishing the appropriate mix of military capabilities will remain great challenges in the years ahead.

The armed forces must prepare for the future without the luxury of focusing their preparations on a single enemy or particular type of conflict. Thus, while the U.S. needs to continue modernizing its conventional military capabilities to deter and, if necessary, fight and win against state-based actors, it also needs to build a force that can deal with a myriad of other challenges. These challenges range from defeating terrorist networks to preventing the acquisition or use of weapons of mass destruction to preventing failed states.

To balance its defense portfolio more effectively, the U.S. must also invest in its strategic forces:

- **Missile Defense.** The U.S. should build a balanced system by concentrating on fielding additional interceptors at sea, in the air, and in space.

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- **Space Capabilities.** The U.S. should execute the President's 2006 Space Policy Directive by achieving space situational awareness, fielding an operationally responsive array of space systems, and developing capabilities to protect U.S. space assets and counter the exploitation of space by hostile forces.
- **Nuclear Forces.** The U.S. should remedy the problem of nuclear weapon atrophy by designing, testing, building, and fielding a new generation of nuclear weapons.

Finally, because the requirements of U.S. forces in the future will likely wax and wane, maintaining a healthy and robust Reserve Component is vital. Reserve Component forces should be updated and adapted to better fulfill the tasks of the 21st century: supporting homeland security activities, theater support operations, and post-conflict missions.

Sustaining the Force. To provide the resources for preparing and fielding the force that the nation needs, Congress must ensure that baseline defense spending is at 4 percent of gross domestic product for the next five to 10 years. This will require adopting fiscally responsible policies in non-defense spending, which must include reforming entitlement spending.

Conclusion. Providing for the common defense is Washington's responsibility, and meeting that responsibility is an achievable goal. Congress and the next President need to make the right choices over the next 10 years to prepare, field, and sustain the all-volunteer force.

If America's leaders make the best decisions, the U.S. will continue to be defended by a military that is trained, equipped, and ready for the tasks of the 21st century. The American people should expect nothing less.

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Providing for the Common Defense: What 10 Years of Progress Would Look Like

James Jay Carafano, Ph.D., Baker Spring, and Mackenzie M. Eaglen

If the President and Congress make the right decisions over the next 10 years, America will have the optimal military to keep the nation safe, free, and prosperous while responding to the emerging national security challenges of the 21st century. Achieving the ideal composition and capabilities of U.S. military forces will require:

- Building a robust complement of capabilities for the spectrum of missions the armed forces will face,
- Ensuring adequate funding for ongoing operations,
- Maintaining a trained and ready all-volunteer force,
- Preparing for the future, and
- Fundamentally reforming manpower and procurement policies.

To realize these goals, both the President and Congress must commit to a program that addresses the most pressing priorities: preparing, fielding, and sustaining the force.

First Principles

Any discussion defining the future force should be rooted in the past and reflect the principles that define the U.S. military's purpose and responsibilities. The purpose of government is to provide for the common defense as prescribed by the Constitution, and the armed forces play an important role in achieving that end. Their primary task is to protect the nation's vital national interests. These interests have proven remarkably consistent and enduring over time and despite the changing threat environment from gener-

Talking Points

- The U.S. military faces an array of future challenges in which no single capability will prevail in every conflict. Meeting these challenges will require a President and a Congress that are willing to prepare, field, and sustain the force that America needs.
- To maintain U.S. military superiority and preserve the all-volunteer force, the U.S. military must cap spiraling increases in manpower costs, adapt Reserve Component forces, maintain access to cutting-edge technologies, deploy a robust missile defense system, obtain military space capabilities, and modernize the nuclear weapons force to address post–Cold War requirements.
- Congress can provide adequately for national security by making the commitment to fund the national defense at no less than 4 percent of GDP for the next 10 years.
- Adequately funding defense will also require adopting fiscally responsible policies in non-defense spending, which must include reforming entitlement spending.

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ation to generation. Heritage Foundation President Edwin Feulner reflected in 1996:

> A band of conservative isolationists on the fringe wants America to withdraw from the world altogether, while a suddenly macho band of liberal interventionists seeks to remake…the rest of the world in its own preening self-image….
>
> The real problem, it seems to me, is that neither group has any conception of America's true vital interests in the real world today.[1]

After 12 years—six of which have been spent fighting the long war against transnational terrorism—Feulner's salient list of America's vital interests is still applicable:[2]

VITAL INTEREST #1: Safeguard U.S. national security.

VITAL INTEREST #2: Prevent a major power threat to Europe, East Asia, or the Persian Gulf.

VITAL INTEREST #3: Maintain access to foreign trade.

VITAL INTEREST #4: Protect Americans against threats to their lives and well-being.

VITAL INTEREST #5: Maintain access to resources.

The first "means, above all, to protect America's territory, borders, and airspace" as well as sea-lanes, space, and cyberspace. Threats to the second may range from both state and non-state entities. With respect to the third, "The greatest danger…comes not from outside U.S. borders but from inside, from those who fear America cannot compete…." Defending the fourth means "an obligation whenever possible to protect American citizens from terrorist and other international criminal activity…."[3]

With respect to the fifth of these vital interests, maintaining access to resources is obviously essential both to long-term U.S. national security and to the country's continuing economic competitiveness. It is in the vital interest of the United States to uphold the principle of freedom of the seas and to promote and protect the ways and means of free trade among nations acting in accordance with the rule of law.

Criteria for U.S. Military Intervention

The best rules for where, when, and how American military force should be brought to bear have also remained historically consistent. Any U.S. military intervention that puts America's men and women in uniform in harm's way should meet the following criteria:[4]

Criterion #1—Military intervention should defend national security interests. Both the President and Congress must recognize that not all national interests are equally important…. For America to use its power effectively, it must prioritize where and how it chooses to defend its vital, important, and marginal interests, thereby avoiding both excessive activism that diffuses important resources and isolationism that eschews important opportunities to shape events.

Criterion #2—Military intervention should not jeopardize the ability of the U.S. to meet more important security commitments…. Huge interventions in areas of marginal security interest have exacerbated the strain on the U.S. military and made it doubtful that the military can mobilize the resources necessary to defend vital national interests and honor current security commitments.

Criterion #3—Military intervention should strive to achieve military goals that are clearly defined, decisive, attainable, and sustainable. Military interventions should be conducted to accomplish clearly definable military goals that are militarily achievable, consistent with overriding political objectives, and supported by enough force to realize these goals….

1. Edwin J. Feulner, "What Are America's Vital Interests?" Heritage Foundation *Lecture* No. 557, February 6, 1996, at *www.heritage.org/Research/PoliticalPhilosophy/HL557.cfm*.
2. *Ibid.*
3. *Ibid.*
4. Taken from John Hillen, "American Military Intervention: A User's Guide," Heritage Foundation *Backgrounder* No. 1079, May 2, 1996, at *www.heritage.org/Research/NationalSecurity/BG1079.cfm*.

Criterion #4—Military intervention should enjoy congressional and public support…. Such decisions should not be made by polls; Americans traditionally are reluctant to intervene. However, when intervention is required, the President should mobilize public support…so that American troops abroad will know that the nation and the Congress support not only the troops, but the actual goals of the operation.

Criterion #5—The armed forces must be allowed to create the conditions for success. The U.S. armed forces must be allowed the operational freedom to create the conditions within which they can succeed.

Blueprint for the Future Military

These principles and criteria help define what the U.S. military is required to do and how it should be employed. They also serve as the blueprint for the kind of military that the nation will need in the decades ahead.

The Past Is Prologue. While U.S. vital national interests have remained consistent, so has the military. America's military has served the nation well since the end of the Cold War. This generation of armed forces has proved that it, too, is the greatest generation. Sustaining the best parts of the military services—the character of the all-volunteer force, the capacity to fight and win conventional battles, the ability to work with friends and allies, and the means to respond in geostrategic regions that are vital to U.S. interests—is essential to building the future force.

Sustaining the Force. If the U.S. military had become "hollow" after the Cold War—as it did following World War II, Korea, and Vietnam—the armed forces would not have been able to respond as effectively to their many post–Cold War missions. While today's force is not hollow, however, chronic underfunding from an excessive post–Cold War "peace dividend" has placed it under grave stress. To prevent the future force from quickly becoming hollow, Congress needs to provide consistent, sustained defense funding, eliminate wasteful costs, and control spiraling manpower costs.

Thinking About the Unthinkable. In the post–Cold War era, Washington has taken great risks by neglecting vital but politically controversial components of defense, such as missile defense, the nuclear deterrent, and space-based defenses. The U.S. cannot afford to continue ignoring these needs simply because of ideological differences.

Establishing a military that has the capabilities and capacity to perform all of the Pentagon missions—from supporting the home front to intervening overseas and winning the peace to dealing with a variety of terrorist threats to defending against ballistic missiles and cyberattacks—requires a President and a Congress that are willing to prepare, field, and sustain the force to protect America.

Preparing the Force

To field the appropriate force for the future, the Pentagon must change how it manages manpower costs and how it acquires goods and services.

Managing Manpower. The cost of maintaining the ranks of the armed forces, including pay and in-kind benefits, represents the largest portion of the annual defense budget.[5] Keeping these costs under control and leaving sufficient funds to modernize the military while maintaining the quality of the force is a significant challenge. A successful future force will adopt policies that cap the spiraling increases in manpower costs.

The success of the all-volunteer military depends on a well-designed compensation package that attracts highly qualified people to military service. A generous and attractive compensation package would focus on compensating military servicemembers in ways that most directly meet their needs. A tailored approach would also ensure that taxpayers get the best return on their investment from the military. Such a custom compensation package would recognize that military personnel, like their civilian counterparts, are part of a highly mobile national labor force.

5. See U.S. Government Accountability Office, *Military Personnel: DOD Needs to Improve the Transparency and Reassess the Reasonableness, Appropriateness, Affordability, and Sustainability of Its Military Compensation System*, GAO–05–798, July 2005, at *www.gao.gov/new.items/d05798.pdf* (February 6, 2008).

Over the course of his or her career, a typical servicemember will move from active-duty service to the Reserve Component and civilian employment. Therefore, a well-designed compensation package would eliminate artificial barriers to the efficient transition of servicemembers among different forms of military service and the civilian sector.[6] The Department of Defense (DOD) refers to this as a "continuum of service" concept for compensation.

Above all, the military compensation package that best supports the all-volunteer force in the 21st century will be flexible. In general terms, this flexibility is best achieved by favoring cash compensation over in-kind and deferred benefits and designing the remaining benefits around defined-contribution plans. Labor mobility makes trying to design benefit packages to meet the unique needs of every uniformed individual difficult and inefficient. Cash compensation would provide servicemembers and their families more freedom in deciding how best to utilize or allocate their benefits.

Emphasizing cash compensation would also likely boost morale in the military because servicemembers tend to compare their pay levels with their civilian counterparts on this basis. The current system, which is biased toward in-kind and deferred benefits, leaves uniformed personnel with the impression that they are undercompensated compared with their civilian peers. This impression lingers even though the Government Accountability Office noted that in 2002, a study "showed that servicemembers generally earn more cash compensation alone than 70 percent of like-educated civilians."[7] Increased cash compensation would therefore help to alleviate a source of resentment in military ranks. Defined-contribution plans would also allow all of the servicemember's employers, including government and private employers, to contribute toward meeting servicemembers' health care and retirement needs.

Congress should continue to provide annual pay increases to military servicemembers over the next 10 years. However, these annual pay increases should be combined with more efficient ways of providing benefits beyond paychecks, particularly in retirement and health care.

The military should reform its current retirement system by adopting, on a transitional basis, a new structure in which the military contributes to each servicemember's retirement account. The plan should also permit the member and civilian government and private employers to make contributions. Finally, the plan should allow the servicemember to bequeath the assets to the servicemember's heirs upon his or her death without paying estate or death taxes. By the end of the 10-year period, all new military recruits would be covered under this new retirement system.

The military also needs to reform the military health care system, which covers servicemembers and their dependents. The military should seek congressional authorization to move health care coverage for dependents to the Federal Employees Health Benefits (FEHB) system on terms consistent with what is available to federal civilian employees. This would permit the military health care system to focus on serving military personnel and meeting the unique requirements of military medicine.

For future military retirees, the military should seek congressional authorization to create a system of defined-contribution plans with individual accounts for military members. The funds in these accounts should be used to pay private health insurance premiums, deductibles, and out-of-pocket medical expenses. As with the proposed retirement system, servicemembers, retirees, civilian government employers, and private employers should be permitted to contribute to these accounts. By the end of the 10-year period, all military dependents should be covered under the FEHB system, and all new recruits should be enrolled in the defined-contribution plan for health coverage.

Exploiting Cutting-Edge Capabilities. Today, the private sector, not the government, conducts most scientific research and development. In addi-

6. James Jay Carafano, "A 'Rucksack' for U.S. Military Personnel: Modernizing Military Compensation," Heritage Foundation *Executive Memorandum* No. 1020, February 14, 2007, at *www.heritage.org/Research/NationalSecurity/em1020.cfm*.
7. U.S. Government Accountability Office, *Military Personnel*, p. 2.

tion, industry is pioneering many of the most cutting-edge technologies (e.g., information technology, biotechnology, nanotechnology, and robotics). In many areas, from information management to logistics, it is business—not the armed forces—that has mastered the most effective practices and developed the capability to deliver the greatest service at the lowest cost. Much of the challenge that the Defense Department faces is the mandate to become more adept at leveraging the private sector's capacity. Part of building a better military over the next decade must include making the military a better customer of private-sector services.

Maintaining access to cutting-edge defense technology is essential to fielding a U.S. military force that outmatches any potential enemy. This will require an acquisition system that neither slows the fielding of advanced technology nor encourages risk-averse behavior by the defense acquisition bureaucracy. Further, the military needs access to cutting-edge technology in a climate where private sector investments in science and technology far exceed military investment, unlike during the Cold War.

Ultimately, providing advanced technology to the military requires a defense market that is both open and dynamic. Regrettably, the defense acquisition system has become so complex and so regulated in the attempt to prevent acquisition failures that the defense market has become largely closed and stagnant. Consolidation of prime DOD contractors during the 1990s had the unintended consequence of discouraging new players from entering the defense supplier network. Without new contractors with non-defense backgrounds, the security sector will lack the creativity necessary to keep the U.S. military technology at the cutting edge.

The remedy is to adopt a broad program for deregulating the defense acquisition system. While this deregulation program should address narrow issues such as curtailing "buy America" provisions and reforming arms export control policies, it should concentrate on removing redundant acquisition review procedures that are designed to prevent acquisition failures. As part of this effort, Congress should reform how it oversees defense procurement and stop using defense legislation to micromanage acquisition programs. Rather, the deregulated system should encourage the Defense Department and DOD contractors to take calculated risks in exploring new defense technologies and not punish either program managers or defense contractors for taking these risks.

The relatively large share of national science and technology investments coming from outside the defense sector means that some of the most promising technologies will originate in the civilian sector. The defense acquisition system must adjust to this reality. The DOD should therefore focus its attention on technological developments in the civilian sector and "spinning in" such technologies to the defense realm.

Congress and the DOD should set goals for the next 10 years to achieve real defense acquisition reform.

First, to increase the number of new defense contractors entering the market, Congress and the DOD should deregulate the market to encourage new contractors to enter voluntarily. They should not impose a new layer of contractor diversity rules, which will likely have the opposite effect.

Second, Congress and the DOD should create a specialized arm of the defense acquisition system to search the civilian sector for new technologies that can be used for defense.

Third, Congress should adopt annual defense authorization and appropriations bills that are less intricate and provide greater discretion to DOD program managers to pursue advanced weapons.

Finally, the military needs to master contracting for war.

The single greatest shortfall in contracting practices in Iraq and Afghanistan was that Washington lacked the capacity to oversee the unexpected massive volume of new defense contracts. For instance, the Special Inspector General for Iraq Reconstruction "found that the shortage of personnel (and the widespread lack of required skill and experience among those available) affected all facets of reconstruction assistance."[8] When the Iraq war started, only 3 percent of the Army's contracting personnel were on active duty, and the Army did not have even one career Army contracting general officer posi-

tion. The commission found that only about half of the contracting officials were certified to do their jobs. At the same time, since the long war against terrorism began, the Army has experienced a sevenfold increase in work.[9]

The resolution of these shortfalls is simple: All of the services must increase the size and quality of their contracting forces, and they need the capacity to expand their forces to meet large-scale contingencies.

To address these varied practical problems, the services—the Army in particular—should begin by reading and implementing their own reports. For example, in October 2007, a commission established by the Secretary of the Army found that almost every component of the institutional Army—from financial management to personnel and contracting systems to training, education, doctrine, and regulations—needed to be bolstered to handle the volume of work experienced by military operations in Afghanistan and Iraq.

A more robust contracting force would include a corps of contracting officers specifically prepared for and trained in "expeditionary" contracting. In other words, unlike writing a contract to provide lawn-mowing services at Fort Sill or buying new headgear, the military's contingency contracting corps must be prepared and ready to deploy overseas. There must also be a clear chain of command for contracting and contractor support for forward-deployed forces on the battlefield and those back at the Pentagon. Not only will this make contracting more responsive; it will also ensure that individuals are held responsible for conducting the people's business.

A bigger contracting force will require institutional support to ensure its effectiveness. This means restructuring organizations so that personnel receive the training, education, practical experience, and support tools that they need (e.g., up-to-date information systems) and the lines of responsibility are clear.

When Washington gets contracting in combat right, there will be experienced and capable contracting officers at *all* deployed locations. This cadre of professionals will have support tools and requisite authorities required to do their job and will work closely with military forces and other interagency representatives in their areas of responsibility. These managers will supervise contracts awarded under a contingency contracting process that is capable of matching available resources to the military's needs.

Fielding the Force

Establishing the right mix of military capabilities will be the military's greatest challenge in the years ahead. The Pentagon needs to reconstitute its forces because equipment and personnel have been worn out by six years engaged in a long war. The armed forces also need to prepare for the future without the luxury of focusing on a single enemy or particular type of conflict.

Building Four Quadrants of Military Capability. The Pentagon's 2006 Quadrennial Defense Review rightly argued that America does not have the luxury of planning for one war alone. Enemies may challenge the U.S. through irregular, catastrophic, and disruptive means—or a combination of these—to deny or degrade traditional U.S. military advantages. The military's future challenges range from defeating terrorist networks to preventing the acquisition or use of weapons of mass destruction to preventing failed states.

At the same time, the United States cannot sacrifice its capacity to fight conventional conflicts. Indeed, unpreparedness makes conventional conflicts more, not less, likely. A great power that lacks the capacity to defend itself is not a great power. It is instead a target—an invitation to aggression.

Nor can America afford to ignore the classic components of deterrence. The age when only a great power could bring another great power to its knees

8. Special Inspector General for Iraq Reconstruction, *Quarterly Report to the United States Congress*, October 30, 2007, p. 25, at *www.sigir.mil/reports/quarterlyreports/Oct07/pdf/Report_-_October_2007.pdf* (February 6, 2008).
9. Commission on Army Acquisition and Program Management in Expeditionary Operations, *Urgent Reform Required: Army Expeditionary Contracting*, October 31, 2007, p. 2, at *www.army.mil/docs/Gansler_Commission_Report_Final_071031.pdf* (January 30, 2008).

is over. Any state and some non-state entities with a modicum of resources could field weapons, such as nuclear bombs, that could inflict heavy casualties and/or devastate the U.S. economy. The United States needs to maintain the means to limit all of these dangers.

Simplistic proposals just to add more ground troops will not suffice. Indeed, no single capability—whether "boots on the ground" or satellites in space—will address all future challenges. A successful 10-year modernization of the military requires a comprehensive plan that demonstrates how the Pentagon will maintain adequate means to deal with threats across all four quadrants of conflict.

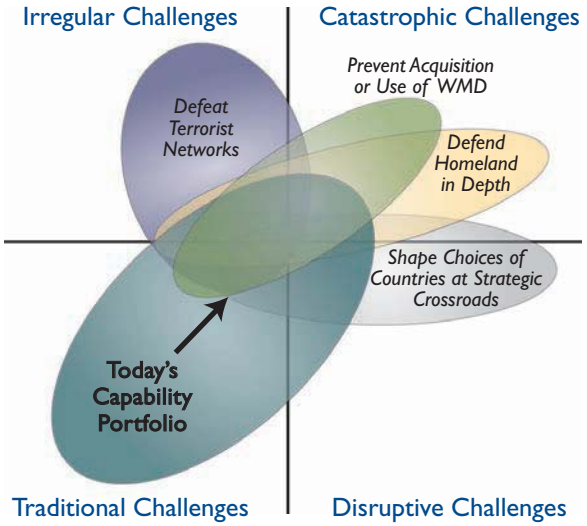
The military must not only be the right size for the long war against terrorism but also be capable of performing the appropriate tasks. The old adage that "every problem looks like a nail when all you have is a hammer" sums up many policymakers' approach to conflict. The Cold War military was a hammer, but a long war demands many more tools.

Expanding the toolbox will be difficult. "Transformation" was the Pentagon's popular exhortation after the Cold War. Few actually agreed on what the effort meant, but every general and admiral seemed to want some.[10] An elementary definition of the term meant providing a new set of military capabilities fundamentally different from those used during the Cold War. The difficulty was deciding exactly what those capabilities would look like. Too often, the answers from the services were that many of the systems and platforms already under development to meet Cold War objectives were transformational and should therefore probably be paid for at the expense of some other service's budget.

More than a decade after the Cold War ended, the transformation rhetoric in the halls of the Pentagon finally appears to be shifting. Talk is moving away from change for the sake of change to transforming the military so that it can carry out the many missions that will be required in the 21st century. Appropriately, much effort is being spent on things that do not fit a single-service paradigm, such as ballistic missile defense, space operations, better information systems, more special operations forces, and unmanned aerial vehicles. These are the hallmarks of the new military coming out of the Pentagon, and the services should continue these important efforts.

Figure 1 B 2108

National Defense Challenges and Capabilities



Source: U.S. Department of Defense, *Quadrennial Defense Review Report*, February 6, 2006, p. 19, at *www.defenselink.mil/pubs/pdfs/QDR20060203.pdf* (February 7, 2008).

Thus, 10 years of progress would include an integrated approach to modernization rather than ceaseless competition among the services to promote particular forces or hardware.

Taking the High Ground. The U.S. defense portfolio has clearly become unbalanced in many respects. A successful 10-year modernization effort will require increasing investments in certain accounts while decreasing efforts to reform and revitalize other defense capabilities. Yet no part of the military requires more urgent attention than U.S. strategic forces.

Missile Defense. By 2018, the U.S. missile defense forces should be more balanced than they are today.

10. For more on the debate about the meaning of transformation, see Ian Roxborough, "From Revolution to Transformation: The State of the Field," *Joint Force Quarterly*, Autumn 2002, pp. 68–75.

The Bush Administration's vision for missile defense is the correct one: a layered defense that can protect against missile attack worldwide. This layered defense would exploit opportunities to counter ballistic missiles in the boost, midcourse, and terminal phases of flight in order to counter missiles of all ranges. It would protect U.S. military forces in the field and U.S. allies, as well as U.S. territory. Finally, it would use the full panoply of basing modes: ground-based, sea-based, air-based, and space-based. The major problem with today's initial missile defense capability is that is extremely unbalanced in these areas.

Listing the missile defense interceptors that are available now or will be available in the near future reveals the lack of balance in the U.S. missile defense posture. These interceptors include roughly 750 Patriot Advanced Capability-3 (PAC-3) interceptors, which are ground-based, terminal defense interceptors for countering shorter-range missiles. Their primary purpose is to defend U.S. forces in the field and U.S. friends and allies in distant regions.

By the end of 2009, the Navy is projected to have over 50 Standard Missile-3 (SM-3) sea-based interceptors and somewhat fewer than 100 SM-2 Block IV interceptors. The SM-3 is a midcourse interceptor that is designed to counter short-range and intermediate-range missiles. It provides theater-area defense to U.S. forces abroad and U.S. allies. The SM-2 Block IV interceptor is being adapted as a terminal defense to counter short-range missiles.

Finally, the Missile Defense Agency is in the process fielding some 44 ground-based midcourse defense interceptors in Alaska and California and 10 missiles in Poland in the coming years.

The current missile defense posture, which is dominated by the PAC-3 system, overwhelmingly favors terminal defenses over boost-phase and midcourse-phase defenses. Indeed, the posture includes no boost-phase interceptors whatsoever. PAC-3 dominance, along with the SM-2 Block IV, also means that the overall posture is much more robust for countering short-range missiles than for countering intermediate-range and long-range missiles. As a result, it offers greater protection to U.S. forces in the field and U.S. allies than to the American people. Ground-based interceptors greatly outnumber sea-based interceptors, and the U.S. has no air-based or space-based interceptors.

Over the next 10 years, the U.S. should deploy a balanced missile defense system by concentrating on fielding additional interceptors at sea, in the air, and in space. Using these basing modes should overcome current deficiencies in countering long-range missiles and intercepting missiles in the boost and ascent phases.

The Department of Defense can achieve this balance by fielding these systems and by concurrently following the acquisition strategy proposed by the Independent Working Group in 2006. This strategy includes:

- Giving future generations of the SM-3 missile smaller and lighter kill vehicles to make them capable of countering long-range missiles and intercepting missiles in the boost phase.
- Testing and fielding space-based interceptors based on Brilliant Pebbles technology developed under the Strategic Defense Initiative. The goal should be to deploy 1,000 Brilliant Pebbles interceptors in space within 10 years.
- Constructing sensor, tracking, and command and control systems that cover the globe and can accommodate both greater numbers of interceptors and newly designed interceptors.
- Maintaining a robust science and technology base to explore the opportunities to field directed-energy weapons, distributed satellite networks, and air-based defenses among other technologies.[11]

Space Capabilities. In 10 years, the U.S. military needs a robust set of space capabilities to execute the national security provisions in President Bush's 2006 Space Policy Directive.[12] The directive tasks the Sec-

11. Independent Working Group, *Missile Defense, the Space Relationship, & the Twenty-First Century: 2007 Report*, Institute for Foreign Policy Analysis, 2006, at *www.ifpa.org/pdf/IWGreport.pdf* (January 30, 2008).
12. White House, Executive Office of the President, Office of Science and Technology Policy, "U.S. National Space Policy," October 10, 2006, at *www.ostp.gov/html/US%20National%20Space%20Policy.pdf* (January 30, 2008).

retary of Defense and the Director of National Intelligence with the primary responsibilities for protecting vital U.S. national security interests in space.

The most important space capabilities can be divided into three general areas: achieving space situational awareness, fielding an operationally responsive array of space systems for national security, and protecting U.S. space assets and countering the exploitation of space by hostile forces.

The first step in preserving U.S. national security interests in space is to acquire space situational awareness—understanding which satellites are in orbit and for what purposes. Until the U.S. achieves such awareness, it will not understand the threats to its own space assets and capabilities that may be faced in the future. Within 10 years, the U.S. should deploy an array of satellites and ground-based telescopes to catalogue and monitor all but the very smallest objects in Earth orbit. A portion of the satellite array may be derived from NASA programs for observing asteroids in the solar system.

In the event that U.S. space assets are disabled or destroyed, the military and the intelligence community need to have backup plans and replacement systems to restore the lost capabilities. This combination of plans and systems is called operationally responsive space. One aspect of the plan is to use distributed networks of small satellites as opposed to a small number of large satellites. A distributed network of satellites would be more survivable against certain kinds of attacks.

The first step is to construct these networks of small satellites and place them in orbit. The second step is to maintain readily available and inexpensive launch systems to replace satellites that are lost in any attack. A shift toward distributed networks of small satellites means that most of the launch systems could be designed to carry smaller and lighter payloads. Within 10 years, the plans should be in place, and the U.S. should have made significant progress toward obtaining necessary systems.

The Space Policy Directive calls for the U.S. to protect its access to space and deny adversaries the use of space for hostile purposes. The policies, plans, and capabilities to fulfill these goals are referred to collectively as defensive and offensive counterspace. The requirements for an effective program of defensive and offensive counterspace are derived from war games and tabletop exercises that are drawn in part from real-world experiences in space operations. The problem is that past war games and exercises may not have been based on realistic assumptions about enemy capabilities. Much of this is because many of the past war games and exercises are classified.

Given the lack of transparency, the first step in attaining effective defensive and offensive counterspace capabilities is to establish an outside group of experts to review the design of these war games and exercises and to consider opportunities for improving defensive and offensive counterspace capabilities that may have been overlooked. This review could be completed by the end of 2008. To the greatest extent permitted by national security concerns, the review and its supporting documents should be declassified. Within 10 years, substantial progress should be made toward fielding, as recommended by this group, a comprehensive array of capabilities to preserve U.S. access to space in the face of hostile actions and to hold enemy space assets at risk. The President in 2018 should have a wide variety of military options for protecting U.S. vital interests in space.

Nuclear Forces. Today, the nation's nuclear weapons infrastructure is atrophying. This is not what was envisioned by the 2002 Nuclear Posture Review, which effectively established a damage-limitation strategy.[13] The damage-limitation strategy is designed to lessen the incentives for other states to acquire nuclear, biological, and chemical weapons; to reduce the likelihood that such weapons will be used in attacks on the U.S. and its friends and allies; and to limit the impact of such attacks.

The source of the problem with the atrophying nuclear infrastructure is an erroneous assumption that U.S. nuclear forces fielded during the Cold War, including the delivery systems, are inherently

13. J. D. Crouch, "Special Briefing on the Nuclear Posture Review," transcript, U.S. Department of Defense, January 9, 2002, at *www.defenselink.mil/transcripts/transcript.aspx?transcriptid=1108* (January 30, 2008).

capable of meeting today's strategic needs. While the number of nuclear weapons in the U.S. arsenal is being reduced from Cold War levels, the U.S. needs to modernize its smaller nuclear arsenal.

The first step in remedying the problem of nuclear weapon atrophy is to establish a plan for modernizing the U.S. nuclear forces in accordance with the Nuclear Posture Review. The President should issue a directive on strategic targeting policy requiring that such a plan should be drafted within a matter of months. It should also direct Strategic Forces Command to identify a worldwide list of targets the U.S. military needs to hold at risk as part of the damage-limitation strategy and to determine how best to hold these targets at risk, whether by defensive systems, conventional strategic strike systems, or nuclear strategic strike systems, including a sufficient level of redundancy.

The nuclear weapons component of the total strategic force needs to meet the requirements of the targeting directive. The Department of Defense should spend the remainder the next 10 years designing, testing, building, and fielding a new generation of nuclear weapons. This effort should extend both to the weapons themselves and to their delivery systems. This modernized force should be optimized to hold at risk the identified targets assigned to the nuclear component of the overall strategic force.

Control the Commons. Getting to the battlefield is half of the fight. To reach future front lines, U.S. forces must be free to transit sea-lanes, control airspace, exploit cyberspace, and thwart enemy attempts to deny U.S. access to potential theaters of conflict. As the National Intelligence Council has aptly noted, "The international order will be in greater flux in the period out to 2020 than at any point since the end of the Second World War."[14] It is generally agreed that:

> Prospective adversaries are developing and fielding…military capabilities that will place US forces operating from large, fixed forward bases, and in the littoral regions, at increasing risk. Consequently, the Pentagon faces new challenges to the operations of air and land forces from overseas bases, as well as how best to structure its maritime forces to operate in the littoral.[15]

Maritime commerce is becoming an increasingly important component of the global economy. This trend both increases the number of potential targets for an adversary and could provide cover for an enemy trying to approach U.S. coastlines undetected. State and non-state groups could launch attacks from U.S. waters using unmanned aerial vehicles (UAVs), short-range ballistic missiles, and cruise missiles, possibly armed with weapons of mass destruction. Terrorists could also use small boats packed with explosives or naval mines to attack commercial shipping in U.S. waters or overseas ports.

In early February, Admiral Mike Mullen, Chairman of the Joint Chiefs of Staff, starkly warned Congress that the military's current strategic risk is "significant." The military's inability to defeat cruise missiles or naval mines, provide persistent surveillance, project power quickly, or operate within a defined "battlespace" (including in the air) places the U.S. military at even greater risk in future conflicts. Defense budgets have to consider the investments needed for tomorrow based on national security requirements. Whether the country needs more Coast Guard cutters, attack submarines, or long-range bombers, military and civilian authorities should carefully and rigorously assess future requirements and hedge accordingly with the right force structures and platforms—many of which will require investment today so that they can enter the force by 2020.

The 2006 Quadrennial Defense Review highlighted the need to create military capabilities to shape and defend cyberspace while maintaining command and control capabilities that can survive

14. National Intelligence Council, *Mapping the Global Future*, December 2004, p. 111, at *www.foia.cia.gov/2020/2020.pdf* (February 6, 2008).
15. Andrew Krepinevich, Barry Watts, and Robert Work, *Meeting the Anti-Access and Area-Denial Challenge*, Center for Strategic and Budgetary Assessments, 2003, p. i, at *www.csbaonline.org/4Publications/Archive/R.20030520.Meeting_the_Anti-A/R.20030520.Meeting_the_Anti-A.pdf* (January 30, 2008).

cyberattacks. The U.S. government, and the military in particular, remains extremely vulnerable in cyberspace and needs to improve its defensive and offensive capabilities quickly. Congress and the President should fully support the effort to thwart America's adversaries in cyberspace as military success in the 21st century will require the ability to deter and defend against cyberattacks and strike at enemies in cyberspace.

Building Reserve Forces for Future Missions. The need for U.S. forces will likely wax and wane in the coming years. In this dynamic environment, Reserve Component forces will remain vital. They provide the flexibility to expand the operational force quickly and efficiently when the demand for troops suddenly increases. In addition, they play a vital role in protecting the homeland and responding to natural and manmade disasters in the United States.

Current stress on members of the Reserve Component reflects the lack of adequate investment in the total force after years of chronic underfunding and the lack of effective personnel policies to manage, train, sustain, and reconstitute Reserve forces. Most disasters, including terrorist attacks, can and should be handled by emergency responders. However, catastrophic disasters—events that overwhelm the capacity of state and local governments—require a large-scale response. Having the military play a prominent role in the immediate response to catastrophic disasters is prudent.[16]

To achieve this mission set, America's reserve ground forces must be large enough to maintain some units on active duty at all times for rapid response and sufficient to support missions at home and abroad. For catastrophic response, the medical, security, critical infrastructure, and oversight components would need to be particularly robust.

Additionally, homeland security forces should be self-deployable, self-sustaining, and capable of operating in austere environments where critical infrastructure is significantly degraded. For example, the Air Force's efforts to enhance its expeditionary airfield capability overseas will be well suited to domestic security in the United States. America's Reserve forces must promptly be freed of less-than-essential homeland defense missions to meet these domestic requirements. This includes current missions such as U.S. Air Force air patrols or U.S. Army supplementation of Customs and Border Protection agents.

The rapidly changing maritime threat environment and the utility of maritime forces in responding to many catastrophic disasters also argue for an organizational structure that better utilizes the Navy's capacity to support homeland security operations. Several states with maritime interests already have state naval militias. Creating a Navy Guard that includes all coastal areas would provide these states with more resources and allow the Navy Guard to focus on state needs when not on active duty. This would also provide a suitable partner for the U.S. Coast Guard to facilitate integration of daily DOD and homeland security maritime operations.

The National Guard needs an equipment modernization program that is specifically designed to meet its unique needs and capabilities. While not ideal, the lack of a modernization program was acceptable when the National Guard was primarily an adjunct to active units, for use typically in the later stages of conflict. Over the past six years, however, the Army National Guard has contributed almost half of all Army troops on the ground in Iraq in certain years and has assumed an increased role in homeland defense missions.

The next Administration will need to restock severely depleted domestic equipment supplies, rethink mobilization policies, update benefit plans for the reserves to allow a continuum of service, and restructure the force size to meet the needs of anticipated future missions. Reserve Component forces should be updated and adapted to better fulfill the tasks of the 21st century: supporting homeland security activities, theater support operations, and post-conflict missions.

16. James Jay Carafano, "The Pentagon's Inadequate Vision for Safeguarding U.S. Soil: What's Needed from the Reserve Components," Heritage Foundation *Lecture* No. 975, November 9, 2006, at *www.heritage.org/Research/NationalSecurity/hl975.cfm*.

The Future Force

The exact composition of the future armed forces—how many Army brigade combat teams, vehicles, ships, aircraft, and Marines—will depend on a number of considerations, including progress in the long war against terrorism, the rise of competing regional powers, and the prospects of U.S. alliances such as NATO. Furthermore, given the evolving threat environment, the right force structure will likely be dynamic, not static.

However, some milestones for force structure choices can be laid out now based on experience from current conflict and impending fiscal and structural challenges. To achieve the needed force structure, the United States, at a minimum, should:

- **Rebuild ground forces.** The Clinton-era cuts in manpower were imprudent. Ground forces should be restored to pre-1998 levels. Additional ground force needs should be based on balancing strategic requirements and manpower costs. In most cases, additional manpower needs should be met affordably by expanding the Reserve Components into a more sustainable and flexible operational Reserve.
- **Preserve the all-volunteer force.** All future military manpower requirements should be met by expanding the all-volunteer force. Conscription and any form of national service should be used only as a last resort in the most dire national emergencies.
- **Expand the capabilities-based force.** The armed forces should increase their capacity to respond to a wide range of missions, including post-conflict operations, counterinsurgency, and homeland defense, but not at the expense of the services' capacity to wage conventional warfare.
- **Revitalize the strategic forces.** The military should develop robust capabilities in missile defense, space-based operations, and cyber warfare.
- **Develop next-generation platforms.** The services should develop and field next-generation systems, such land vehicles, cruisers, and bombers.
- **Exploit cutting-edge technology.** The military will need new technologies (e.g., directed-energy weapons, unmanned combat aerial vehicles, and other robotic systems) that give it a significant competitive advantage over future adversaries.
- **Maintain air supremacy.** The U.S. military must retain the capability to dominate airspace in any theater, including space and cyberspace.
- **Maintain the capacity to control sea-lanes and defeat anti-access strategies.** Naval and Marine forces should concentrate on these core missions, while other maritime "constabulary" missions should increasingly be assigned to the Coast Guard.

Sustaining the Force

The third and likely greatest challenge for Congress and the Administration over the next 10 years will be providing the resources to sustain a military that is capable of carrying out the national military strategy within an acceptable margin of risk over the next several decades.

Spending at Least 4 Percent of gross domestic product (GDP) on Defense. Americans are often surprised to learn that, by historical standards, federal defense spending is relatively modest, particularly given that the United States has been at war since September 11, 2001, and is conducting major military operations in Afghanistan and Iraq. Indeed, members of America's military have made well over 2 million individual deployments to Iraq and Afghanistan.

While Americans are firmly committed to maintaining a strong national defense, they often defer to their leaders in Congress to reflect their views and take appropriate action. Regrettably, some Members

of Congress are already predicting a post-Iraq peace dividend and procurement holiday. Some Members are already posturing to accept, if not encourage, a significant drawdown of the defense budget within as little as two years even though America's service chiefs have told them that war-related bills will continue to come due for at least three years after major combat operations subside.

Even though the recently passed fiscal year (FY) 2008 defense budget provides about $460 billion to the baseline Pentagon budget, it fails to answer the question of whether or not this commitment to national defense will be sustained for the next four years of the five-year budget period. The current Administration has deferred cost estimates of ongoing operations in the war on terrorism because projections are impossible this far in advance. This omission, however, shows defense budgets declining after FY 2008 to 3.2 percent of gross domestic product (GDP) by FY 2012.

Spending significantly less than 4 percent of GDP on defense for the next five to 10 years would shortchange the military. Such underfunding would ultimately produce a hollow force that is either too small, unable to sustain current operational demands, not ready, or at a technological disadvantage on the battlefield.

Congress can provide adequately for national security by making a firm commitment to fund the national defense at no less than 4 percent of GDP for the next 10 years. This commitment would require Congress to add roughly $400 billion to the defense budget for from FY 2009 to FY 2012, which it could do in the 2009 budget resolution. A portion of this money would be allocated to ongoing operations, while the remainder should go to the core defense program, with a special emphasis on developing and deploying the next generation of weapons and equipment.

Under current and future budget projections, the services are scheduled to field new platforms that will anchor U.S. security for the next generation. America can afford the necessary upgrades. Over the long term, federal spending should be reformed to provide adequate funding for current defense needs, and the shape of the U.S. military should continue to evolve to reflect future threats. Rather than reduce defense spending, the next President and future Congresses should commit to providing for the nation's defense by spending at least 4 percent of GDP on defense and ensuring that those resources are spent well.

Adopting Fiscally Responsible Policies. The United States has a $13 trillion economy. As a result, modest economic upticks and downturns, such as a mild recession or modest inflation, are unlikely to affect defense spending significantly. However, inadequate long-term fiscal policies from Washington could cripple the economy, placing the overall competitiveness of the United States—and defense spending—at risk.

Economic productivity and growth are essential to providing for the common defense. To foster economic growth, Washington policymakers should:

- **Restrain non-defense discretionary spending.** Spending not related to defense and post-9/11 operations has increased by 49 percent since 2001, or 5.9 percent annually compared to 4.2 percent growth under President Bill Clinton. Since 2001, spending on education has grown by 7.5 percent per year, health research by 7.3 percent, and international affairs by 8.0 percent. At a time when defense and homeland security priorities require especially tight non-security budgets, Members of Congress have not made necessary trade-offs. Instead, they have *accelerated* the growth of non-security spending.
- **Bring entitlement spending under control.** Taxpayers cannot afford the massive intergenerational transfer of wealth that Social Security, Medicare, and Medicaid will soon require. European economies are already being crushed under the weight of their expensive social insurance programs, and the United States must take steps now or meet a similar fate. This means modernizing these social insurance programs to make them sustainable.

  As baby boomers shift into retirement, they are living longer, more productive lives. Congress should gradually raise the retirement age to reflect this change. It should also target benefits by reducing premium subsidies for higher-income retirees and tying benefits to income.

Over the long-term, Congress should reform Medicare into a market-based system that provides seniors with the right to choose better coverage if they wish to do so. Seniors would also benefit from the intense competition that private health plans would bring.[17]

- **Repair the budget process.** Lawmakers still cling to an antiquated budget process created in 1974. During the past 30 years, successive Congresses have punched this process full of holes, and federal spending has tripled. The current budget process provides no workable tools to limit spending, no restrictions on passing massive costs onto future generations, and no incentive to bring all parties to the table early in the budget process to set a framework.

  America's budget priorities have changed, and so should its budget process. Congress should ensure that the long-term costs of entitlements are built into the budget process and considered along with other priorities during the annual budget debate. Congress should also put all programs, including entitlements, on a more level playing field. It should do this by creating a long-term budget framework for entitlements that is revisited every five years along with "triggers" to make automatic adjustments if spending grows above budgeted levels.

- **Reform the tax code and permanently reduce the tax burden.** Today's tax system is an obstacle to economic growth. Taxing capital through capital gain and dividend taxes, the death tax, and corporate tax reduces economic growth and has a dampening effect on income investment, jobs, and wage growth. High marginal personal income tax rates also deter growth by disincentives to work, save, and invest. The United States has the second-highest corporate tax burden (35 percent federal tax rate plus an average of 5 percent at the state level) in the industrialized world, which reduces U.S. competitiveness in the global economy. Economists estimate that the current tax system imposes mammoth costs on the U.S. economy, suppressing economic output by as much as 15 percent.[18]

  Annual growth rates could be much more impressive if the tax system did not punish productive behavior. To create an environment that better fosters growth, Congress should make the tax code flatter and simpler, reduce or eliminate taxes on capital, and ensure that U.S. tax policies are internationally competitive. The more competitive the United States is economically, the better able it will be to provide for its own security.

Conclusion

Providing for the common defense is Washington's responsibility, and meeting that responsibility is an achievable goal. Congress and the next President need to make the right choices over the next 10 years to prepare, field, and sustain an all-volunteer force that is trained, equipped, and ready for the tasks of the 21st century. The American people deserve nothing less.

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17. See Robert E. Moffit and Alison Acosta Fraser, "Congress Must Pull the Trigger to Contain Medicare Spending," Heritage Foundation *WebMemo* No. 1796, February 4, 2008, at *www.heritage.org/Research/Budget/wm1796.cfm*.
18. James Jay Carafano and Paul Rosenzweig, *Winning the Long War: Lessons from the Cold War for Defeating Terrorism and Preserving Freedom* (Washington, D.C.: The Heritage Foundation, 2005), pp. 148.

'Technology's Role in Addressing National & Global Priorities'

James R. O'Neill, Corporate Vice President and President, Northrop Grumman Information Technology, Jan. 31, 2007

***Speech to the* Northern Virginia Technology Council Titans of Technology**

Opening Greetings—

I am honored to be with you this morning. This body does important work in giving voice to some of the issues that matter to this region and to our nation and our world.

The number of those issues seems to grow every year. And it is a continuous parlor game trying to assign places for them on our collective priorities list. The pollsters certainly work hard at this. There have been many polls recently that try to identify the issues that concern our three hundred million fellow citizens, and try to determine just how concerned about them we are. All the major television networks and newspapers – as well as Gallup, Newsweek, Time, Harris, and others – have conducted polls along these lines and here are the issues common to most of them. They include terrorism, national security, health care, energy prices, the economy, immigration, Iraq, the environment, job growth, nuclear proliferation, crime, and education.

So I thought it might be interesting to try to reduce this vast sampling of issues to a few manageable categories, and take a look at what technology stands to bring to their solutions.

Of course, our time this morning won't allow a detailed analysis of any of these categories.

I'll say at the outset that my company, Northrop Grumman, has interests in some of the issues I'll mention, but not in all. I should also say in advance that I will be approaching these categories from an IT perspective. This is not just because I lead my company's IT sector. It is also because I believe that information technology is the heart and soul of technology today. Remarkable progress is being made in genetics, pharmaceuticals, communications, chemistry, physics and many other disciplines. But IT is the engine that is driving the progress in each. For example, the human genome project would not exist without the advances we have made in IT. Today, the systems you stuff into a military aircraft are more important than the aircraft itself.

So, what are the categories? I think we can put most of the issues I mentioned into four buckets: First, would be National Security and it would include the defense of our nation and our allies as well as maintaining our homeland security and assuring public safety.

The second bucket is Healthcare – not just the advance of medical science, but reducing its costs, improving its quality, and making it more available to everyone.

Global Competitiveness would be the third one – assuring a strong economy, job creation, and competitiveness in a world economy.

And the fourth bucket would be energy and the environment – accelerating energy efficiency, developing new sources of energy, and protecting the planet.

So, let's start with defense. America has a very specific way of waging war. We choose to invest in technologies that will allow our forces to win conflicts as quickly as possible, while sparing as many lives as we can. Think of the unmanned aircraft that have been shot down over the past several years. Each pile of wreckage represents an American pilot that was not killed or taken prisoner. That speaks to the American way of war, and most of the technologies that make it possible can be divided into two groups: Assured Access, and network-centricity.

What do I mean by assured access? I'm talking about technologies that give our military the ability to reach out wherever and whenever our national leaders deem it necessary. And to do so with enough power to accomplish whatever mission those leaders assign. Recall the air strikes against Libyan President Khaddafi in 1986. That strike almost did not happen because Spain and France denied us over-flight privileges. Our aircraft had to take off in Britain, and fly out over the Atlantic, around the Iberian Peninsula, strike their targets and return by the same route. It added almost 3000 miles to the mission and made it more dangerous than it needed to be.

It's easy to see what kinds of technologies and systems offer assured access: Stealthy aircraft, refueling tankers, radar jamming; cyber warfare, submarines, aircraft carriers, special operations, transports – both sea and air, precision strike, secure communications, even missile defense.

The other group comprises those technologies that advance the cause of Network-Centricity. The objective of network-centricity is to clear away – as much as possible – the fog of war; to answer the four questions that soldiers have been trying to answer since the beginning of organized

warfare: Where am I?; Where are my buddies?; Where is the enemy?; and what are we doing about it?

Over the course of the last century, progress was made along these lines most notably with radio communications and aerial observation. We now have the technology to advance that progress by a quantum leap. This will be done by integrating sensors and communications to give every war-fighter a common picture of the battle space.

Let me give you an example. One piece of this puzzle is what is called Blue Force Tracking. Think of a laptop that displays a map picture of your immediate area with friendly units marked in blue and unfriendly units marked in red. Imagine that this map picture moves and changes as you move. No matter where you go, or what time of the day or night you go there, you will always know where the good guys are – the blue force. It is in use today and has prevented many friendly fire incidents. Jessica Lynch's convoy, on the other hand, was not equipped with Blue Force Tracking when they drove into that ambush four years ago. They were still using paper maps.

Sensors, communications, and integration are the keys to network-centricity. This means integrating unmanned aerial vehicles, satellites, and airborne radars into a graphic representation of the battle space that can be accessed by everyone from Generals and Admirals to corporals. And yes, it does have utility in anti-insurgent operations. Where ever the fog of war is thickest, the utility of network-centricity is greatest.

The other half of the National Security category is Homeland Security. It includes such things as border security, the security of our coastal waters, and, even more basically, the security of our urban areas. As many of you might know from having followed the various congressional hearings and independent reviews of the 9-11 attacks, the first responders in our major cities – police, fire, and medical units – seldom know what the others are doing, where they are, or even how to contact them due to incompatible radios and other communications. New York City was the first to tackle this problem with an integrated, mobile, broadband wireless communications system for public safety personnel. They can now access federal and state anti-crime and anti-terror databases, get finger prints, mug-shots, city maps, and even streaming video all from their police cars or fire trucks.

But New York City is the exception, not the rule. Just this month, the U.S. Homeland Security Administration issued a scorecard on 75 of our largest urban and metropolitan areas. The scorecard observes that, while most of our major metropolitan areas have plans and policies in place for interoperable communications, the actual implementation of those plans is

generally lagging – this a half decade after 9-11. As New York City's Mayor Bloomberg said last year,

"One of the most important lessons learned from September 11th was that our emergency responders need better access to information and clearer lines of communication in the field."

Police Commissioner Kelly agreed, adding,

"The future success of crime fighting and public safety in general is wedded to the ability to quickly access data and share it."

Other nations – with other policies – are also bringing technology to bear on the issue of public safety. The UK has a program called IDENT1. It consists of a national identification database, including fingerprints. And they are just starting to introduce a system called LANTERN into the equation. LANTERN is a small hand-held fingerprint reader that police can use on the roadside. A suspect sticks his index finger into the unit. It reads the print and automatically runs it through the IDENT1 fingerprint database to check for a match. British police expect this system to speed up roadside stops, maximize the time police officers spend on the beat and minimize the time they spend down at the station doing reports. As you can see, policy has to keep up with technology. They allow that kind of instant fingerprint checking in the UK. They don't here. The difference is one of policy, not technology.

The second category of issues facing our nation is healthcare.

There are currently over 44 million Americans without health insurance and costs for them continue to soar. And this problem will only get worse for several reasons. First, our population is aging at a very fast clip. Figures from the United Nations show that this is a serious issue the world over with different regions aging at different rates. For North America, the UN projects that by 2050 the percentage of people aged 60 and over will nearly double. And those figures – alarming in their own right – don't take into account the pace of scientific and medical breakthroughs that will lengthen lifespans. It might be said that our health care system is the victim of its own success. For example, scientists are making rapid progress with genetic mapping. This will most certainly result in the ability to head off certain diseases proactively, or at the least, identify those at risk for certain diseases. Proactive treatment is expensive.

But at least we can see this coming, even if we choose to do nothing about it. What about those events we cannot foresee? Things like pandemics and bio-terrorism? A pandemic will spread with the speed of an airliner. As for bio-terrorism, technology places the creation of lethal strains within

the reach of more and more fanatics every year. One wonders what 9-11 might have looked like if Osama bin Laden had been a biologist instead of an engineer.

For years, people have predicted that information technology would provide solutions to many of these problems. In fact, IT has made little headway against them. For one reason, the amounts spent on IT in the health sector are among the lowest of any sector. The banking industry spends an annual average of $15 thousand per employee on IT. In the healthcare industry, that figure is $3 thousand per employee. Most doctors understand how this translates. This month's Fortune magazine reports that doctors consistently rank billing and claims processing as their number one problem, even ahead of malpractice. But it also has implications for patient care. The Institute of Medicine reports that between 50,000 and 100,000 hospital patients die each year because of medical errors due largely to a lack of automated information systems. Apart from complicating treatment, this shortcoming raises costs. One in five lab tests and imaging studies are performed simply because previous test results are unavailable. If you watched the State of the Union speech last week, you heard the President say, quote, "We need to reduce costs and medical errors with better information technology," unquote. The applause that followed was bi-partisan.

Some of the speed bumps to expanding IT in the health care sector are the need for records privacy, and the different laws and policies among the states in place to protect it. There is currently a pilot program underway to harmonize all these different privacy policies with federal law. It makes electronic health records available to clinics nation-wide, and interconnects health care professionals with local, regional, and national records exchanges. This effort could contribute to a National Health Information Network.

Work being done with the Department of Defense could also help bring the potential of IT to the health care sector. They have set up a health information exchange for their nine million members, which makes electronic health records available to clinics nationwide. This DoD program could blaze the trail for the rest of the country.

The third category of concern for most Americans could be titled Global Competitiveness. How do we maintain our economic growth, national affluence, and leadership in a world economy that every year grows more and more defiant of national borders?

First, I think we have to resolve ourselves to the fact that, like the march of technology itself, the global economy is here to stay.

This is true even for the high tech industries that we Americans excel at. Last year in aerospace, for example, the joint Italian/British firm of Augusta Westland, along with Lockheed, won the contract to supply the next generation of White House helicopters for America's future presidents.

The same trend applies to more down-to-earth sectors as well. American auto workers build Hondas with parts imported from around the world. Those cars are "American made" even though Honda's corporate headquarters is in Japan. Fords are now manufactured in Russia, though Ford's corporate headquarters is located here in America. The corporate headquarters of Chrysler is now in Germany, but many Chryslers are made in Canada as well as the U.S.

Since we cannot run away from this global economy, we had better learn to master it. And master it we can, because international markets pose not just challenges, but opportunities. Yes, American business has to contend with low cost labor in India, China, Eastern Europe and other locations. And yes, our nation has been off-shoring jobs to those places for some time now. But we are also starting to see opportunities for on-shoring – sending jobs away from traditional venues, but to more competitive locations here in the U.S.

There is precedent for this. Let's return to automobiles. As you know, Ford just reported its worst year in its 103 year history. The rest of the "Big Three" are also having problems. But Mercedes, Toyota, Hyundai, Nissan, and others are opening plants here in America. They are building plants in rural America for the same reasons we opened our own facility in southwestern Virginia – in Lebanon. Later this year, Northrop Grumman will open an IT support center there. We will bring 400 good-paying jobs to a part of the commonwealth that is primed for economic expansion, and has lower labor costs, an educated work force, and a good quality of life. Everybody wins: The Commonwealth, the employees, my company, and our customers.

Globalization does not have to be a threat, but mastery of it assumes a healthy free market. That is good for us because ideas, innovation, vision, managed risk, are all distinctly American. They are what we do best. And more than that, they are the foundation of the commodity of our age – intellectual capital. Let me explain.

Every age has its governing commodity. In past times it may have been precious metals, military power, agricultural surplus, trading or financial acumen. Master the governing commodity of your age, and you stay out in front. For many decades, up until thirty or forty years ago, the governing commodity of our age was industrial capacity. We were the kings of that commodity – hands down. On December 7th, 1941, the Imperial Japanese

Navy had ten aircraft carriers to our seven. By war's end, three and a half years later, they had four still floating and we had a hundred.

But the governing commodity of our age is no longer industrial capacity. Today it is intellectual capital. We lead the world because we lead that commodity. It is the basis of our leadership in pharmaceuticals, medicine, communications, computers, aerospace, genetic engineering, defense technology, and many other categories. If we lose our leadership in intellectual capital, we lose our position of leadership in the world.

And there's the rub, because we are not keeping up. For several years America has been bracing for a tidal wave of retirements of our best technical minds. When that wave hits, we will have difficulty replacing them. In recent years U.S. universities have graduated around 70,000 engineers annually. Meanwhile, India graduates about 200,000 per year and China over 500,000. And the quality of those engineers is becoming every bit as good as our own.

American students are avoiding math and science in high school and college. As Tom Friedman said in his book, The World is Flat, I dare you to find an eleven year old in America who wants to be an engineer today. And those students who do want to take math and science have trouble finding teachers. U.S. school districts will need to hire 240,000 middle school and high school math and science teachers by 2010 to correct the shortage. This is not a problem to brush off. Nearly a year before the September 11 attacks, the U.S. Commission on National Security in the 21st Century, headed by Senators Gary Hart and Warren Rudman, concluded among other things that, quote, "The inadequacies of our system of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine," unquote.

On balance, globalization has been good for everyone. The world economy is expanding at a rate of about 4.4% after inflation, and nation after nation has moved from dysfunctional centralized economies to free-market systems. In turning away from their past practices, those nations performed a collective act of courage. But this is often the price of progress. Gary Hamel of the Harvard Business School said, quote, "Studying the future is not the ability to see the future, it's the ability to walk away from part of the past" unquote. The way to keep our place as the world's foremost economy is not to try to hide from this new global economy, but to master it. Intellectual capital is the key, and we have to renew our leadership of that commodity.

Finally, there is the category of Energy and the Environment. Obviously, technology has a critical role to play in the solution to our dependence on

foreign oil, and the protection of our environment. It is proving particularly useful in making existing energy sources more efficient. I agree that these issues will eventually require solutions that are a bit more revolutionary than evolutionary. For example, we might make the internal combustion engine more efficient, but what is really needed is a quantum leap in battery capacity.

In the end, however, the solutions will have to be market based. Therefore, technology will make its greatest contribution when it can be synchronized to the market place. This means embracing the basics of business – Business 101: Coming up with a product that is energy efficient, environmentally friendly, and desired by the customer – that's the magic formula. Electric cars have been around for years, but even subsidies have not brought them traction in the market. Americans are Affluent and independent-minded enough that they will pay extra for the kind of car they want no matter how inexpensive you make the cars they don't.

Technology has been a continuous tale of problems solved, problems created. But the stair-steps have clearly gone upward on the graph of the human condition.

They have gone upward on the graph of the environmental condition as well. The industrial revolution gave jobs to millions. It also gave us the modern city with all its early problems of pollution, over-crowding and disease. For example, the advent of the 24 hour factory shift created a need for illumination – a need that helped create the whaling industry almost destroying that species. What saved the whales was the new petroleum industry which brought us kerosene. Its by-product was gasoline, so useless at first that it could not be sold and was often flushed down the rivers at night.

Electrification also helped solve the need for illumination and teamed with another technology to solve another problem that grew out of the modern city – the horse. In the 1880's, the people of New York City shared their town with 170,000 horses. They pulled carriages and street cars, but they also produced 43,000 gallons of urine and 2500 tons of manure every day. The manure spread tetanus and the flies spread typhoid. And the 15,000 dead horse carcasses produced every year were often tossed into the rivers and bays.

Some visionaries saw the new automotive technology as the savior of their cities. And to an extent, it was. The electric, oil, and auto industries – made possible by a free market system that rewarded innovation – soon drove the horse out of the cities, making them livable and improving the environment in innumerable ways.

Today, we are looking for ways to reduce greenhouse gasses caused, in part, by the automobile. I cannot tell you what the solution will look like, but I will bet you this much: That the solution will come in the form of a combination of technology and free-market incentives, and not in the form of government programs, controls, or trade restrictions. I'll also bet you that whatever solutions we find to the problem of green house gas emissions will produce other problems that we won't foresee.

So, these are the issues of our times: National security, healthcare, globalization, and energy and the environment. The good news is that the potential of technology to solve our problems is far from used up. In fact, it is just getting started. Let me leave you with a quote from the British historian, Paul Johnson. He said, quote, "The species Homo Sapiens is less than 1 million years old. Civilization has existed for only about 8000 years. The Industrial Revolution occurred less than 250 years ago. We've harnessed electricity for only 150 years, and atomic power for half a century. The rate of advance is accelerating very fast indeed, yet the pace is going to quicken at a speed we cannot now imagine. We are only at Chapter One in the story of humanity and its glories," unquote.

As long as it is accompanied by good judgement and careful planning, technology has much to offer to these challenges. These are exciting times and I'm glad to be around for them.

Thank you.

Economic Growth in the Defense Sector

While the U.S. economy slowed in the third calendar quarter, defense spending leaped, far outstripping other government agencies. It is tempting to draw the conclusion that defense spending is somehow not aligned with the rest of the economy. Here is why that conclusion is incorrect.

According to the Commerce Department's Bureau of Economic Analysis (BEA), which tracks U.S. economic activity, defense spending rose 18.0 percent from the second calendar quarter to the third, on a seasonally adjusted, annualized basis in constant dollars.[1] The third quarter of 2007 saw a similar increase, when the annualized rise in defense spending exceeded that of federal spending, which in turn also outpaced overall U.S. economic growth.

The BEA's GDP estimate includes a high-level analysis of defense spending, which provides some insight on why spending rose in the third quarter. Recasting the GDP data on a quarterly basis in current dollars shows that the biggest dollar contributors to the increase were compensation, personnel support, weapons support, and installation support.

Why did defense spending increase?

The most significant explanation for the jump in spending is the late date of the FY2008 defense supplemental appropriations act, which was not approved until the end of June. The Defense Department had been doing everything it could to stretch dollars until the supplemental was passed, at which point all the accounts were made whole, with only one quarter remaining to spend it.

Source: Department of Defense

Annualized Percent Change from Prior Period (measured in constant dollars)

	2007				2008		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3
GDP	0.1	4.8	4.8	-0.2	0.9	2.8	-0.5
Federal	-3.6	6.7	7.2	-0.5	5.8	6.6	13.6
Defense	-5.9	8.5	10.2	-0.9	7.3	7.3	18.0
Non-Defense	1.2	3.1	1.2	0.4	2.9	5.0	4.5

Source: Bureau of Economic Analysis, "Gross Domestic Product: Third Quarter 2008 (Preliminary)," news release, November 25, 2008, http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm.

[1] The BEA reports quarterly data on an annualized basis and calculates percentage change by multiplying the change from one quarter to the next (in real terms, -0.13%) by four (to get -0.5%).

For months, actions had been delayed, regular maintenance was pushed back, and contracts were not signed until the supplemental came in. Much of that delayed spending was in the three support categories that together accounted for 46 percent of the increase in spending.

Top growth categories:

Weapons support includes depot service and maintenance for new weapons systems. The BEA estimates depot maintenance service from contract awards data. Estimates for new weapons systems are derived from financial reports as a percentage of disbursements for each major weapons system. This category saw 76% annualized growth in current dollars in the third quarter.

With last summer's high fuel prices, petroleum spending rose slightly more than 9 percent, a 37% annualized rate in current dollars. From the third quarter of 2007 to the third quarter of 2008, defense spending on petroleum rose more than 48 percent.

Personnel support includes contracts for consulting, training and education (estimated by the BEA based on contract awards), and direct hire of foreign nationals (estimated by the BEA based on a DOD survey). This category saw 40% annualized growth in current dollars in the third quarter.

Installation support includes BEA estimates for electricity, natural gas, telephone, postage, housekeeping, water, sewage and steam, communication, rent, contractor-operated facilities, and maintenance of real property and equipment. In the third quarter, this category saw 36% annualized growth in current dollars.

—Matthew Zlatnik and David Berteau

Quarterly Defense Spending by Category
(measured in billions of current dollars)

	2008 Quarterly (1)			Q3'08 /	Q3'08 /
	Q2	Q3	Chg.	Q2'08	Q3'07
Total Defense	**$180.8**	**$189.9**	**$9.1**	**5.0%**	**12.4%**
Compensation	63.0	64.5	1.5	2.4	7.8
Petroleum	4.7	5.1	0.4	9.1	48.2
R&D	15.6	15.6	0.1	0.5	10.6
Installation support	10.1	11.0	0.9	8.9	13.7
Weapons support	7.7	9.1	1.5	19.0	18.6
Personnel support	19.2	21.1	1.9	9.9	17.9
Other consumption (2)	37.2	38.6	1.4	3.8	9.0
Investment (3)	23.6	25.0	1.4	5.9	19.4

(1) Calculated by dividing the government's annualized figures by four.
(2) Includes some purchases of aircraft, missiles, ships, vehicles, electronics and other durables, depreciation as measured by national income accounting, transportation and travel.
(3) Includes structures, some vehicles, aircraft, missiles, ships, electronics and software and other equipment.

Source: Bureau of Economic Analysis, News Release, November 25, 2008, Table 3, http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease, and Table 3.11.5, National Defense Consumption Expenditures and Gross Investment by Type, http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N
Because the data is in current dollars, not constant dollars, the annualized percentage increase in spending will vary from the constant-dollar figure.

For more information, please see:

Bureau of Economic Analysis (BEA), "National Income Accounts," http://www.bea.gov/national/index.htm; and BEA, *Government Transactions: Methodology Papers: U.S. National Income and Product Accounts* (Washington, D.C.: Bureau of Economic Analysis, September 2005), http://www.bea.gov/national/pdf/mp5.pdf.

Energy and the Future of World-Class Manufacturing Investments in Virginia

Mike Petters
Corporate Vice President and President,
Northrop Grumman Shipbuilding

On Friday, December 5, 2008, Mike Petters, Corporate Vice President and President, Northrop Grumman Shipbuilding sector, addressed the Virginia Manufacturer's Association's Virginia Industry Leadership Forum in Williamsburg, Va. Below are his remarks.

I'd like to thank the Virginia Manufacturer's Association for inviting me to speak at this conference. I think forums like this are very important as they enable business and government leaders to come together, share challenges, and explore solutions that are applicable to any of us involved in manufacturing – solutions important to the continued economic viability of our state and our individual business enterprises.

As a business leader, I often speak about what I believe are the main challenges facing the Commonwealth of Virginia in maintaining its manufacturing base. I consistently talk about the need for Virginia to focus on three areas – transportation, energy and work force development. So you probably won't be surprised when I tell you that these are the three things I'm going to cover today with more emphasis on the last two – energy and work force development. And then I hope to have time for your questions.

First, however, I'm going to tell you a little bit about Northrop Grumman Shipbuilding.

Northrop Grumman Shipbuilding is one of the seven sectors of Northrop Grumman Corporation, the third largest defense company in the world. Of those seven business sectors, four of them have huge footprints in the state of Virginia. Shipbuilding is made up of shipyards in Newport News, Virginia; Pascagoula, Mississippi; and New Orleans, Louisiana – with nearly 40,000 employees.

Also located in Virginia are Technical Services in Herndon, Information Technology in McLean and Mission Systems in Reston. There is also a sector, Integrated Systems, located in El Segundo, California and the Electronic Systems sector is located in Baltimore.

Northrop Grumman Shipbuilding builds nuclear-powered aircraft carriers and submarines, and surface combatants and amphibious assault ships for the US Navy – as well as cutters used in Homeland Security for the US Coast Guard. We are the Navy's largest supplier and the Navy is our biggest customer. We have annual revenues of nearly $6 billion. With 40,000 employees we have a big footprint in three states as the largest employer in both Louisiana and Mississippi and the largest manufacturer in Virginia.

And as we all well know, our current economy is in a rough patch but the news for manufacturing hasn't been kind for quite some time. We hear all too often about the decline of the American manufacturing base. And the news stories about plant closings and job losses paint a picture that doesn't seem to project a lot of hope about this sector of the economy. Let's just look at the facts about manufacturing to get a sense of where we really are:

> The manufacturing sector produces $4.5 trillion in goods, yet we are consuming fewer and fewer of our own goods as the trade imbalance reflects;
>
> At the beginning of 2008 there were less than 14 million manufacturing jobs in the United States – the fewest since 1950;
>
> Yet, manufacturing accounts for nearly three quarters of the nation's industrial research and development and two-thirds of our exports; and
>
> More than 8 million jobs are created through ancillary employment.

Without a doubt manufacturing counts for a lot in America's economy and in the economy of Virginia. Speaking for Northrop Grumman Shipbuilding alone, our economic activity has contributed greatly to the regions it serves – and it's a result of many strong partnerships with our states. In Louisiana, our direct payroll contributes more than $240 million

annually to the economy and indirect employment adds another $200 million. In Mississippi, our direct payroll contributes $450 million annually to the economy and indirect employment adds another $216 million. For Virginia, the direct payroll was just under $1.1 billion and the indirect number adds another $518 million.

But manufacturing in America and in Virginia could become an endangered species because regulatory and tax policies that create artificial barriers coupled with a lack of investment by government in helping to educate a manufacturing workforce are resulting in us falling behind. This is my transition to the discussion about workforce, transportation and energy.

As the largest manufacturer in Virginia, work force development – having the right people at the right time with the right skills – is a top priority for us. A few months ago we signed a contract to build the first ship in a new class of nuclear-powered aircraft carriers – the Gerald R. Ford class. In the next decade or so, I need to hire somewhere in the range of 15,000 employees to help build this ship and the ones to follow it. Where am I going to find these people? Will they have the right skills?

At Northrop Grumman Shipbuilding, we're not waiting for someone to answer these questions for us. In fact, we're strong believers in controlling our own destiny to the extent that we can. So we've partnered up with many organizations – public and private – to seek out solutions. A few of the many examples of where we've worked with communities and the state to deliver results in Virginia include:

- A strong partnership with the local school systems, reflected clearly in the Newport News Public School's pilot program, Career Pathways. By working with businesses and industry in the area, partnerships have been established that direct the educational efforts of the school systems to help graduates make a seamless transition into the workforce.
- We developed a state-of-the-art manufacturing curriculum for Thomas Nelson Community College and assisted them in acquiring a National Science Foundation manufacturing excellence grant;
- We've worked with multiple community colleges to help develop their curriculum so these graduates can begin working at our shipyards – and being valuable contributors – the day they graduate. For example, in Newport News, where welding is also a critical skill, Thomas Nelson Community College is offering a welding certificate to help develop the future workforce we need.
- We participate in a corporate program called Weightless Flights of Discovery – a program where middle and high school science and math teachers experience zero gravity aboard a plane. This allows them to relate to what it's like to be an astronaut – an experience that they hopefully pass on to their students in a way that gets them excited about pursuing a career in math or science.

There are also similar examples demonstrating what we've done and what we're doing in the states of Louisiana and Mississippi. We've learned, through hard work and the success that follows it, that working together with the States is the best – and really the only way.

And now on to transportation.

In addition to the need for people to build Ford, we will purchase more than $3 billion of material, including that supplied by the government. This material must get to the shipyard in time. It comes by air, sea and rail but most of it comes by roads. This underlines the need for an efficient transportation system that is highly functional. It also underscores the need for business leaders to get into the fight for good transportation. And finally, it takes a tremendous amount of energy to build ships – especially the kind that weigh more than 100,000 tons and serve as a floating city, airport and home to thousands of sailors. Not surprisingly, the shipyard in Newport News is one of the top energy customers in Virginia. Last year we purchased nearly $31 million worth of electricity, natural gas and fuel with more than half of this expenditure going for electricity. I believe Virginia should generate its own power for its own citizens and export the excess. This would be good for business and a good economic development opportunity for the state, which leads me to the topic I'm going to spend the rest of my time on today and that's the joint venture between AREVA and Northrop Grumman Shipbuilding that was announced in late October.

This joint venture – named AREVA Newport News – is a great example of how manufacturers can work with the government in ways that help both work force development initiatives and our energy challenges in a very innovative and enterprising way. In fact, AREVA Newport News also links together national economic needs, global energy requirements and national security in a way that enhances each. First, some background.

We began exploring the opportunity to enter the commercial nuclear energy market some years ago. The statistics speak for themselves. According to Dale Klein, chairman of the Nuclear Regulatory Commission, the Department of Energy estimates the US demand for electricity will increase 50 percent in the next 30 years. Another study done this year by the Energy Information Administration gives a different but still equally impressive statistic – it says that the US demand for electricity will grow 25 percent by 2030. An AREVA study projects that by 2030 world demand for electricity will double, driven largely by emerging and developing countries. They also estimate that 344 new nuclear power plants will need to

be built by 2030 and the total number of nuclear power plants globally will be 635. Another source, Dennis Spurgeon, Assistant Secretary of Energy for civilian nuclear programs, has stated that he anticipates 55 countries will be operating 630 reactors by 2030. So the market for nuclear power appears to be emerging.

And US attitudes-historically skeptical on the use of nuclear power – seem to be changing.

An April 2008 NEI survey found 59 percent of Americans surveyed think the US should "definitely" build more nuclear power plants. And 63 percent favor using nuclear power for US electricity while 33 percent oppose. All of these statistics and research and much more due diligence led us to this deal with AREVA. It was a well-thought out, well-researched effort.

My experience is that shipyards can get themselves into trouble by reaching too far for new business. What has proven to work, though, is when shipbuilders can find niche markets – markets where they have skills that are unique. The partnership with AREVA is such a market. It capitalizes on what we do at Northrop Grumman Shipbuilding in Newport News. We do the hard stuff right. We build large, complex machinery and we have a nuclear shipbuilding culture. AREVA is a global leader in electricity transmission and distribution. They need a supplier to manufacture these heavy components for their reactors. We have those capabilities, a location on the James River well-suited for barging components, and most importantly, a highly-skilled workforce. Once the AREVA Newport News facility is complete, we will have the capacity to manufacture heavy components for nuclear reactors for the commercial market. Our involvement builds upon Northrop Grumman's commitment to national security by supporting the nuclear energy resurgence, fueling domestic economic growth, and meeting the demand for American energy independence.

This venture, with the Commonwealth of Virginia's participation – that came in the form of financial support from Governor Kaine's opportunity fund, a grant from the Virginia Investment Partnership program, and tax incentives – also means that we continue an important and critical investment in the manufacturing workforce in Virginia – a goal I believe everyone here today shares.

It's also a strong demonstration of Virginia investing in the businesses that are investing in work force development themselves. In summary, I've laid out some of the very real challenges we're facing at Northrop Grumman Shipbuilding – challenges I feel certain are not ours alone and that many of you share. Yet I'm hopeful that I've also shown you that the solutions lie in working together – business with business and industry with government. Cooperative partnerships – arrangements that are mutually beneficial – are the ones that have the greatest chances of succeeding.

That doesn't mean that they are easy – in fact, they are sometimes much harder to do. It just means that they end up being worth it. I'm confident that AREVA Newport News will be worth it.

National Science Board

RESEARCH AND DEVELOPMENT: ESSENTIAL FOUNDATION FOR U.S. COMPETITIVENESS IN A GLOBAL ECONOMY

A Companion to Science and Engineering Indicators - 2008

NATIONAL SCIENCE FOUNDATION

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National Science Board

Dear Colleague:

As part of our mandate from Congress, the National Science Board (Board) oversees the collection of a very broad set of quantitative information about U.S. science, engineering and technology, and every 2 years publishes the data and trends in our *Science and Engineering Indicators (Indicators)* report. On occasion, the data reveal trends that raise important policy concerns that the Board believes should be brought to the attention of the President, Congress, and the public in the form of a "companion" policy statement to the *Indicators* report.

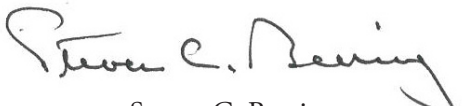
The 2008 volume of *Indicators* reinforces the Board's concern with declining support for U.S. research and development (R&D), especially basic research, by U.S. industry and the Federal Government. The confluence of a range of indicators raises important questions about future U.S. high technology industry's competitiveness in international markets and implications for highly skilled jobs at home. The importance of understanding the implications of these indicators underscores the need for new metrics to guide Federal Government investment strategies for R&D to more effectively enhance international competitiveness of the U.S. in high technology.

This Board Companion Piece, *Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy* (NSB-08-3), examines currently available data and recommends the following.

- The Federal Government should take action to enhance the level of funding for, and the transformational nature of, basic research.
- Industry, government, the academic sector, and professional organizations should take action to encourage greater intellectual interchange between industry and academia, with industry researchers encouraged to also participate as authors and reviewers for articles in open, peer-reviewed publications.
- New data are critically needed, and this need should be addressed expeditiously by relevant Federal agencies, to track the implications for the U.S. economy of the globalization of manufacturing and services in high technology industry.

We urge all Americans to support sustaining our Nation's long-term commitment to basic research and to a strong U.S. R&D enterprise, coupling the advantages of our world leading academic research institutions with our strength in industrial science and technology. Our continued commitment is essential to our Nation's future prosperity and security.

Sincerely,



Steven C. Beering
Chairman
National Science Board

Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy

Our hope is that there will be full employment, and that the production of goods and services will serve to raise our standard of living...Surely we will not get there by standing still, merely by making the same things we made before and selling them at the same or higher prices. We will not get ahead in international trade unless we offer new and more attractive and cheaper products...There must be a stream of new scientific knowledge to turn the wheels of private and public enterprise. (Vannevar Bush, 1945)[1]

U.S. Basic Research: A Need for Serious National Attention

U.S. industry and the Federal Government are the primary pillars of financial support for the U.S. research and development (R&D)[2] enterprise. The National Science Board (Board) observes with concern the indicators of stagnation, and even decline in some discipline areas, in support for U.S. R&D, and especially basic research, by these two essential patrons and participants. A decline in publications by industry authors in peer reviewed journals suggests a de-emphasis by U.S. industry on expanding the foundations of basic scientific knowledge. More specifically, research contributions by U.S. industry authors in the physical and biomedical sciences through publications in peer reviewed journals have decreased substantially over the last decade. In addition, in this century the industry share of support for basic research in universities and colleges, the primary performers of U.S. basic research, has also been declining. Likewise, Federal Government support for academic R&D[3] began falling in 2005 for the first time in a quarter century, while Federal and industry support for their own basic research has stagnated over the last several years. These trends are especially alarming in light of the growing importance of knowledge-based industries in the global economy.

The confluence of these indicators raises important questions about implications for the future of U.S. competitiveness in international markets and for the future existence of highly skilled jobs at home. The net economic and workforce effects on the Nation and on industry of these negative changes are complex, and the Board finds that requisite data for an adequate analysis of current conditions and future trends do not presently exist. Nevertheless, the Nation must be acutely aware of the current trends as future resource allocations for basic research are debated and decided in industry and by the Federal Government.

Global Competition in Science and Technology: A Strong National Response Required

Innovation is a key to economic competitiveness and the technological breakthroughs that improve our lives. Basic research fuels technological innovations and is critical in fostering the vitality of the U.S. science and technology enterprise and the growth of highly-skilled jobs. The scientific and technological advances that have led to our Nation's remarkable ability to create new industries and jobs, improve the standard of living for people, and provide sophisticated technology that ensures our national security can be traced back to the outcomes of basic research.

Although industry funds two-thirds of U.S. R&D, the majority of basic research is conducted by research universities, and the U.S. Government has long recognized the importance of public support for these institutions. The Federal Government established the basis for the Nation's land grant institutions through the Morrill Acts[4] in the second half of the 19th century. During World War II, the wartime success of the partnership between universities and the Federal Government through the Office of Scientific Research and Development (OSRD) led to a proposal – requested by the President – from the head of OSRD for public funding for research, specifically basic research, in academic institutions and research institutes. Such funding would encourage the creation of knowledge and employ science and engineering (S&E) for discovery and innovation—and thereby expand national economic growth, increase employment, and improve the quality of life. This proposal ultimately led to the creation of the National Science Foundation (NSF).

The conduct of basic research is international in character and, in today's global environment, its benefits are widely shared by all nations. At the same time, America's economic competitiveness relies on the ability to exploit scientific and technological advances. The country in which a discovery is made has an enormous initial advantage in exploiting such advances in understanding. Furthermore, by maintaining strength in a variety of basic research fields, we will be positioned to benefit from the breakthroughs made by investigators in other parts of the world.

— National Science Board, 1993[7]

Through its support of entities that fund basic research, the U.S. Government helps underwrite our national infrastructure for science and engineering R&D and thereby the global preeminence of the U.S. in S&E innovation. Over time, the Federal Government support for R&D, and the related important efforts of industry, have grown into a complex and changing web. Given the impacts on the national innovation infrastructure of changes in investment patterns, it is imperative that patterns and trends of R&D investments be monitored.

Extending beyond U.S. borders, dramatic changes have occurred that have led to a new global economy operating in ways not envisioned even several decades ago. As with our own Nation, innovation and its hand maiden, R&D, is driving the global economy, and we are seeing more nations recognize this by creating their own version of U.S. research institutions and infrastructure. U.S. businesses are taking advantage of the global markets and resources, and are increasing their support for research and R&D infrastructure outside the U.S. At the same time, industry support for its own U.S. basic research has been fairly stagnant in this century,[5] and its support to academic basic research in the U.S. has remained at most flat, and declined in share of support for academic R&D to a level not seen in more than 2 decades.[6] The rapid changes taking place internationally increase the urgency of understanding and monitoring where our Nation stands in its R&D competitiveness, the direction of trends related to competitiveness in high technology, and what critical information may be lacking that would provide more accurate assessments of the Nation's standing and outlook.

Basic Research: A Declining National Commitment

In 2006 the total expenditure for R&D conducted in the U.S. was about $340B in current dollars. Of this total, basic research accounts for about 18% ($62B), applied research about 22% ($75B), and development about 60% ($204B).[8] Over the past decades the U.S. institutions contributing to the output of basic research have shifted dramatically.[9] Although industrial contributions to national R&D now far outpace Federal R&D support, only about 3.8% of industry-performed R&D can be classified as 'basic', with the remainder devoted to applied R&D. For industry-funded and performed R&D, the basic percentage is about the same for 2006, 3.7%. This percentage of basic research performed by industry has hovered slightly below 4% of all industry-performed R&D for most years since the late 1990s.[10] In 2006, industry funded 17% of U.S. basic research, and performed 15% of it.

The Federal Government is the second largest source of R&D funding (28%) following industry. Federal expenditures vary greatly from agency to agency in terms of amounts, directions, and objectives, depending upon the mission of the particular agency.[11] Federal funding is the primary source of basic research support in the U.S. (over 59% in 2006[12]), of which about 56% is carried out by academic institutions. U.S. basic research is also funded by foundations (about 10%), universities and colleges (about 10%), and state and local governments (about 3.5% through funding of academic basic research).[13] Federal obligations for academic research (both basic and applied) and especially in the current support for National Institutes of Health (NIH) (whose budget had previously doubled between the years 1998 to 2003) declined in real terms between 2004 and 2005 and are expected to decline further in 2006 and 2007. This is the first multiyear decline in Federal obligations for academic

research since 1982.[14] The intent of Federal policy is to increase support for physical sciences research in future years.[15]

International Competitiveness of the U.S. in Science and Technology

The relative increase in R&D and basic research of foreign nations as compared to the U.S. can (in some ways) work to the advantage of U.S. industry. Domestic industries can learn and profit from the R&D that is carried out in other countries and reported in the literature. Basic research that is published can be used freely by all nations, and the benefits do not necessarily accrue to the industries or nations that fund the research. However, as the Board stated in 1993,[17] there are enormous advantages to those industries and nations who are first with discoveries.

A review of quantitative indicators of the state of U.S. science and engineering in the new *Science and Engineering Indicators 2008* provides some measure of U.S. international standing in R&D. The total 2006 R&D in the U.S. (about $340B) comprised about 2.6% of the Nation's gross domestic product (GDP). The ratio of R&D to GDP is a widely used measure of an economy's R&D intensity. From a high of about 2.9% of GDP in the early 1960s (after the Sputnik "scare"), the Nation's R&D expenditures have hovered around 2.5% of GDP in the last decades. With 2.6% of its GDP devoted to R&D, the U.S. ranks seventh among OECD[18] countries, and second among G-7[19] countries (as it has for the last more than a decade at least). U.S. funding for R&D has exceeded 50% of the total G-7 nations' R&D since 1997. In 2002 (the latest global data available), the U.S. expenditures for R&D were one third of the world-wide total R&D (over $800B in current dollars).

Countries can be compared over time with respect to contributions to knowledge and innovation using two indicators of research outcomes: (1) patents, as a measure of a nation's inventiveness and (2) publications by authors from the respective nations in peer reviewed journals, as a measure of cutting edge S&E capabilities.

Patents

The share of patent applications in the U.S. patent office filed by inventors[20] residing in the U.S. dropped from 55% in 1996 to 53% in 2005. The percentage drop was largely caused by the increasing filings by Asian inventors. Inventions for which patent protection is sought in the world's three largest markets – the U.S., the EU,[21] Japan – are called "triadic patent families." The U.S. has been the leading source of triadic filings (about 37% of the world share) since 1989, when it surpassed the EU, and its share has continued to increase. The U.S. position in patent filings and in triadic patents suggests sustained U.S. leadership for inventions.

Companies that innovate might not always choose to secure every innovation through patenting. Some innovations can be retained as trade secrets. Growing, maintaining and defending a patent portfolio involves costs, so that companies must evaluate the marginal benefits of individual patent filings. On the other hand, cross-licensing of patents can be competitively beneficial for companies, as can the revenue received from licensing or sale of patents. Thus, motivations for patent filings, and therefore the significance of declines in the share of U.S. filings, are not well understood.

Although many people assume that the United States will always be a world leader in science and technology, this may not continue to be the case inasmuch as great minds and ideas exist throughout the world. We fear the abruptness with which a lead in science and technology can be lost – and the difficulty of recovering a lead once lost, if indeed it can be regained at all.

— The National Academies, 2007[16]

Publications

Basic research articles published in peer-reviewed journals by authors from U.S. private industry peaked in 1995 and declined by 30% between 1995 and 2005[22] as industry research, and therefore publications, tended to shift away from basic research. Five broad fields – biological science, geosciences, chemistry, physics, and medical sciences – account for 95% of the industry basic research literature. The drop in physics publications was particularly dramatic: decreasing from nearly 1,000 publications in 1988 to 300 in 2005.[23]

The decline in physics publications by U.S. industry is likely reflected in the observed drop in share of highly influential[24] S&E articles published by U.S. authors in peer reviewed journals: The U.S. has now dropped from first to second rank in physics over the 12-year period from 1992 to 2003. The U.S. retained the first rank in all other major fields in 2003, but overall lost share of highly influential articles, dropping from 63% to 58%. Other fields where the U.S. declined to near parity with the EU-15[25] in recent years are biology and chemistry, also traditional focus areas for industrial basic research publications. This most likely reflects, in part, the decline in U.S. industry authors' publications, and flat (or decreasing as in the case of physics) industry support for its own basic research. In the field of engineering/technology, although the U.S. lost share while the EU-15 gained, the decline in U.S. share more importantly reflects the rapid rise in share by the East Asia-4 (comprising China, South Korea, Singapore, and Taiwan). U.S. annual growth in all S&E article publications in peer reviewed journals also slowed from 3.8% over the period from 1988 to 1992 to 0.6% from 1992 to 2003. Although the rate of growth also declined for the EU-15 and other S&E publishing centers, all exceeded the U.S. growth rate during both periods.[26]

Intellectual Property and Industrial Innovation

Patents and publications do not necessarily equate to innovation and thus do not reflect the totality of industrial innovation. In global, competitive, high technology industries, some innovations might be more cost effectively protected by means other than patenting. In addition, research and/or commercial priorities might direct limited resources towards further advances in research or to addressing how to apply the results of the innovation rather than publishing articles. As a result, any basic research that may have contributed to such processes is unknown to (and unrecorded in) the wider community. Further, under these conditions the wider community cannot be alerted to possible basic research directions that might be productive for achieving new breakthroughs.

The growing competitiveness in the global environment is resulting in new business models such that the impact of innovations might not be captured in current international trade metrics. Companies might innovate and create intellectual capital in one country that is then utilized in designing and developing products, services, applications, etc. in that country or another. The actual fabrication might occur in yet another country. The complete process from creation of intellectual capital and high-tech design through to fabrication and distribution of products, services and applications can be performed across many countries in a global supply chain that can result in cost-effective products for consumers. Although the transfer of a physical product across a border may be recorded in such a process, if no intellectual property licensing occurs, the value of the intellectual capital may not be captured by the current global trade metrics. Furthermore, some international commercial transactions (sale, payment, product delivery) in such an environment are not simply bilateral exchanges between two countries. Instead, such transactions may involve multiple flows of information, components, products/services/applications, and payments that are not easily correlated. In parallel with new metrics to capture this type of innovation, the traditional Federal Government investment strategies for basic research may need to be adapted to the emerging environment of discovery, innovation, and deployment in order to more effectively support the web of connections between R&D investments and U.S. competitiveness.

Competitiveness of U.S. Industry

Another measure of competitiveness is the U.S. international trading position in high technology industries. The U.S. trading position in technology-oriented services remains strong as evidenced by the continued surplus in trade of computer software and manufacturing know-how.[27] By current measures, the U.S. trade balance across all high technology sectors significantly declined over the last decade. This could translate into the loss of manufacturing jobs[28] in high technology industries, although the data are insufficient to measure the impact on employment over time.

Of the five high technology manufacturing industries identified by the OECD, only that for aerospace had a large positive balance of trade in 2005. The scientific instruments industry is relatively balanced with regard to trade, and the other three high technology manufacturing categories are negative. The total U.S. trade balance in high technology shifted from surplus to deficit in the late 1990s, with a deficit of $32B in 2000, increasing to $135B in 2005. This increase primarily reflects increases in the deficits with Asia.

In contrast to the manufacturing category, the U.S. trade balance in royalties and fees for intellectual property between affiliated and non-affiliated companies has continued a sustained surplus over the years.[29] Licensing fees and royalties largely reflect past innovations, sometimes quite distant past, and are not good measures of the current state of research or accurate predictors of future intellectual property revenues from the research.

Global Investment by Industry in Innovation

U.S. industries are establishing R&D facilities and manufacturing facilities in nations in which they have markets and in which they wish to grow market share. Such facilities can also contribute to more cost-effective manufacturing capabilities to the benefit of consumers in the U.S. and elsewhere. Off-shore facilities for engineering design are also being established by U.S. industry, especially in China and India. Such R&D can benefit U.S. industry's products, profitability, and over-all competitiveness, as well as provide some limited domestic job growth. However, critical data on these trends in off-shoring R&D by U.S. industry are presently lacking, as is the net effect of such trends on industrial competitiveness and domestic job growth.

Foreign nations continue to establish R&D centers in the U.S., as well as manufacturing facilities in some industries. Foreign companies also support some academic R&D, including endowed professorships. There are limited data on these trends, as well as on the net economic effects on the U.S. of the "out-sourcing" of R&D by U.S. companies and of the "in-sourcing" of R&D funded by foreign companies. However, Indicators data on R&D by multinational corporations are instructive. These data show that affiliates of foreign companies located in the U.S. made $29.9B in R&D expenditures in 2004, little changed from 2003. Between 1999 and 2004, R&D by these affiliates increased faster than overall U.S. industrial R&D (2.1% on an annual average rate basis after adjusting for inflation, compared with 0.2% for U.S. industry overall).

On the other hand, foreign affiliates of U.S. multinational corporations performed $27.5B in R&D abroad in 2004, a rise of $4.7B from 2003, the largest annual increase since a 22% rise in 1999. This amount nearly equals the R&D by affiliates of foreign countries in the U.S. ($29.9B).[30] Affiliates located in Europe represented slightly more than two-thirds of the 2004 increase.

The Road Ahead: Conclusions and Recommendations

The stagnation in industry support for its own basic research in this century, together with the current decrease in support of academic R&D and basic research by the Federal Government could over time have severe implications for U.S. competitiveness in international markets and for highly skilled and manufacturing jobs at home. However, the net economic effects on the Nation and on industry of the off-shoring of manufacturing capabilities are complex, and appropriate data do not exist for adequate analysis of present situations and future trends.

For more than a quarter century U.S. industry has dominated the funding of U.S. R&D. The Federal Government continues to dominate research funding to the academic sector. The recent three-year decline in Federal obligations for academic research, the first since 1982, and the decrease of support by industry for basic research could pose significant problems in that academic researchers, primarily supported by Federal funds, are now likely to have less available funding and to be considerably less aware than previously of the major research challenges that face U.S. industry and industrial competitiveness. Further, with fewer industry researchers focusing on basic research, a company may be unable to readily tap into the expertise and facilities of the university community.

To keep America competitive, one commitment is necessary above all: We must continue to lead the world in human talent and creativity … With more research in both the public and private sectors, we will improve our quality of life – and ensure that America will lead the world in opportunity and innovation for decades to come.

— President George W. Bush, 2006[31]

1. Based on past experience, basic research can be expected to be a major driver in the future for innovations that result in new industries and new jobs, and that will enhance the Nation's global competitiveness.

   Recommendation: ***The Federal Government should take action to enhance the level of funding for, and the transformational nature of, basic research.***

2. The decrease in industrial-based basic research may result in a decreasing level of interactions between industry and academic research and teaching. In addition, changes in some industry's policies related to the management of patent portfolios and to publishing peer-reviewed journal articles are likely limiting public awareness of some innovation. It is unknown how much, if any, basic research in industry results in innovations that remain company-proprietary, or that could beneficially influence the directions of any basic research.

   Recommendation: ***Industry, government, the academic sector, and professional organizations should take action to encourage greater intellectual interchange between industry and academia. Industry researchers should also be encouraged to participate as authors and reviewers for articles in open, peer-reviewed publications.***

3. In the area of high technology manufacturing of products and services, globalization has often resulted in "value flows" across several nations before the end user acquires the device or service. Current trade measurements monitor the flow of components and products, but do not track at present all of these value flows. New metrics would be valuable in order to accurately attribute where value is added and, therefore, where intellectual capital is created and skilled labor is employed. Basic research is crucial to advancing science and engineering and creating intellectual capital in the United States, and for the U.S. to continue to add value and to provide leadership in the global marketplace.

   Recommendation: ***New data are critically needed to track the implications for the U.S. economy of the globalization of manufacturing and services in high technology industries, and this need should be addressed expeditiously by relevant Federal agencies.***

Industry and the Federal Government bear special responsibility for the health of U.S. science and technology in the emerging global economy. Several indicators, described earlier, imply a reduced commitment to the U.S. enterprise by both the Federal and industry sectors—especially to academic and basic research—over the last several years, in spite of the growing importance of knowledge-based industries in international trade. The potential impacts of persistent negative trends in R&D support, and especially support for basic research, on the U.S economy and jobs are indeed troubling. As a Nation we must renew our strong commitment to R&D to ensure our continued preeminence in global science and technology. New metrics are required to guide national R&D investments in all sectors to ensure that we respond to the research needs in a rapidly changing global economy.

Endnotes

[1.] Vannevar Bush. *Science—The Endless Frontier.* National Science Foundation, Washington, DC, 1980: 18.

[2.] **Research and Development Definitions:**

Research is defined as systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research is classified as either basic or applied according to the objectives of the sponsoring agency.

Basic research is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

Development is defined as systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

[3.] Federal obligations for R&D controlling for inflation.

[4.] Morrill Acts of 1862 and 1890, *http://www.higher-ed.org/resources/morrill_acts.htm*. Accessed 27 October 2007.

[5.] National Science Board (NSB). 2008. *Science and Engineering Indicators 2008* (SEI 2008), Arlington, VA: National Science Foundation. Appendix table 4-8.

[6.] NSB. 2008. Appendix table 5-2.

[7.] NSB. 1993. *In Support of Basic Research* (NSB-93-127). *http://www.nsf.gov/nsb/documents/1993/nsb93127/nsb93127.htm*. Accessed 27 October 2007.

[8.] NSB. 2008. Chapter 4.

[9.] Contributions to basic research are indicated by publications in science and engineering peer-reviewed journals.

[10.] NSB. 2008. Appendix table 4-8. In 2003, basic research exceeded 4% of industrial R&D, reaching 4.2%.

[11.] **Primary Federal R&D funding agencies:**

Department of Defense: the largest Federal R&D funding agency devotes about 89% of its estimated FY2007 expenditures of $56B to development.

Health and Human Services (primarily NIH): about 55% of the R&D budget of $29B in FY2007 is devoted to basic research.

National Aeronautics and Space Administration: about 55% of the total R&D FY2007 budget of $8B is basic and applied research.

Department of Energy: about 67% of a FY2007 R&D budget of $8B is spent in Federally Funded R&D Centers (FFRDCs).

National Science Foundation: about 91% of the FY2007 of $6B is devoted to basic research.

U.S. Department of Agriculture: about 69% of the $2B FY2007 R&D budget is intramural funding.

[12.] NSB. 2008. Appendix table 4-9.

[13.] National Science Foundation, Division of Science Resources Statistics. 2007. *National Patterns of R&D Resources: 2006 Data Update*. NSF 07-331. Brandon Shackelford and John E. Jankowski, project officers. Arlington, VA, Table 6.

[14.] Consistent with this trend, reported Federal expenditures for academic R&D declined between 2005 and 2006. A decline in real terms in Federal expenditures for academic R&D had not previously occurred in the last quarter century.

[15.] America COMPETES Act. (H.R. 2272)

[16.] National Academies. 2007. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future,* National Academies Press. *http://books.nap.edu/openbook.php?record_id=11463&page=3*

[17.] National Science Board, op. cit. Accessed 27 October 2007.

[18.] Organisation for Economic Co-operation and Development, *http://www.oecd.org/home*. Accessed 27 October 2007.

[19.] **G-7**: The United States, Japan, Germany, France, United Kingdom, Italy and Canada. G-7 finance ministers meet several times a year to discuss economic policy. *http://www.hm-treasury.gov.uk/otherhmtsites/g7/g7_members.cfm*. Accessed October 27, 2007.

[20.] Inventors can be individuals or organizations. Most are organizations.

[21.] **EU**: European Union, comprising 27 countries.

[22.] NSB. 2008. Appendix table 6-28.

[23.] NSB. 2008. "S&E Articles in Peer Reviewed Journals/Articles in Basic Research Journals" in chapter 6.

[24.] "Highly influential" defined by citations by other authors.

[25.] **EU-15**: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK.

[26.] Derek Hill, Alan I. Rapoport, Rolf F. Lehming and Robert K. Bell. 2007. *Changing U.S. Output of Scientific Articles: 1988-2003*. Arlington, VA: National Science Foundation.

[27.] Manufacturing "know-how" is defined as industrial processes used in the production of goods, sold as intellectual property. See SEI 2006: 6-23.

[28.] The nature of jobs associated with "manufacturing" in high-technology industries varies greatly. They may include basic research, applied research, systems engineering, planning, design, development, fabrication, sales, distribution, customer support, etc. Trade statistics often reflect the value flows due to the fabrication and the distribution of products, services and applications to a customer destination. In practice, value flows due to other job functions may not be reflected in trade statistics. This could be significant in considering current employment and trade statistics as indicators of national competitiveness.

[29.] "Affiliate" is defined as "A company or business enterprise located in one country but owned or controlled (10% or more voting securities or equivalent) by a parent company in another country; may be either incorporated or unincorporated. See SEI 2008, 6-45.

[30.] NSB. 2008. Chapter 4: Highlights, 4-52.

[31.] George W. Bush. 2006. State of the Union Address. *http://www.whitehouse.gov/stateoftheunion/2006/index.html*. Accessed 3 December 2007.

Cover Credits: The cover for *Research and Development: Essential Foundation for U. S. Competitiveness in a Global Economy* celebrates the 2007–09 International Polar Year with a montage including photographic images from the polar regions. At the center is an ice cave at Loudwater Cove, on Anvers Island. Arcing above it and to the left are smaller images showing (counterclockwise): a team of seal researchers in Antarctica by the light of research vessel Laurence M. Gould; the elevated station and flags of the original 12 Antarctic Treaty signatory nations at Amundsen-Scott South Pole Station. A sundog, caused by diffraction of ice crystals, can also be seen; an aurora borealis, and a sunset at Cape Hallett. *(Credit, ice cave: Zenobia Evans, National Science Foundation (NSF); Credits for images counter clockwise: Steve Trumble, NSF; Scott Smith, NSF; Patrick Smith, Ken Ryan, NSF.)*

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