SEMINAR SERIES

ON

U. S. DEFENSE INDUSTRIAL BASE PREPAREDNESS

Sponsored by the

ASSOCIATION OF THE UNITED STATES ARMY
AUSA - Institute of Land Warfare
2425 Wilson Boulevard
Arlington, VA 22201
(703) 841-4300

and

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION
ADPA - "The Voice of the Industrial Base"
2101 Wilson Boulevard
Suite 400
Arlington, VA 22201
(703) 522-1820

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FOREWORD

As a follow-up to a 20 November 1991 AUSA conference on defense acquisition, a small group of the original participants met on 23 December 1991 to explore the issues further. From these two meetings a number of topics and areas of special concern emerged with respect to the future state of the defense industrial base. It was agreed that these issues should be explored in greater depth.

In response to this need, the Association of the United States Army (AUSA), in conjunction with the American Defense Preparedness Association (ADPA), sponsored a series of half-day informal seminars throughout January and early February 1992. The objective of the seminar series was to define and assess industrial base issues on a sector basis and to develop proposed strategies to ensure the base's ability to meet future security needs. Although the series started with essentially an Army orientation, it became apparent that the issues and industrial capabilities discussed had defense-wide applications. Observations and recommendations, therefore, were expressed in a total defense perspective.

Each seminar addressed a different sector, including land combat systems, aviation, missiles, high technology and communications, and ammunition. Also, a seminar was held to address the role of defense trade. Attendees included senior industry executives of representative sectors, senior members of the Army's logistics and acquisition communities, and experts from academic and professional institutions.

A briefing based on the seminar series was developed and used to inform cognizant national leaders of the need for a strategy to ensure the viability of a defense industrial base for future contingencies. The briefing has been presented to a broad cross-section of industry representatives and to selected Army and senior administration and congressional personnel as appropriate. Copies of the briefing are available on request.

This monograph, with a detailed bibliography, addresses the substance of the seminars and the parameters which will shape the industrial base sectors in the future.

JACK N. MERRITT
General, USA Ret.
President
Association of the
United States Army

LAWRENCE F. SKIBBIE
Lieutenant General, USA Ret.
President
American Defense
Preparedness Association

EXECUTIVE SUMMARY

The key observations and thrusts developed in the monograph are as follows:

- The defense industrial base is plagued by uncertainty about the future and without clear government insight into the required end state for each product sector. The base has overcapacity in a period of lower acquisition budgets. This means reduced incentive for capital investment in a modernized capability. At the same time, U.S. industry is faced with increased foreign competition.

- The need to downsize the defense industrial base is a given, but it must be done in an orderly fashion. Without a plan, a mismatch may well develop between DoD requirements and the industrial base capability to support.

- To reduce the overall problem to manageable levels requires the identification of discrete military-unique sectors and combat-essential products, and then a definition of the minimum essential needs in both the government and private components of the base.

- An investment strategy must be developed to maintain the combination of private and government sources with the capability to support a system through the full development, production and sustainment life cycle. The program mix would include the sum of RDT&E, procurement, upgrades and modifications, spares, operational maintenance, depot maintenance and defense trade. RDT&E should be fully funded. The overall DoD program for each essential military capability should be adjusted to assure the minimum essential industrial capability required in both the government and private components.

- A balance must be sought between essential contractor and government industrial capabilities. This should consider a combination of continued production of current items, P3I, prototyping, low-rate production of new systems and defense trade.

- Industry consolidation should be encouraged.

- We need to consider and support new ways of doing business, such as more turn-key contracting with life cycle management vested in a the prime contractor. We must define essential core government capabilities and encourage government depot and private industry worksharing. Barriers (cost accounting, restrictive specifications, etc.) to dual-use (military and commercial) production must be removed.

- While the competitive process should be continued where there is an established base that allows for competition between contractors who meet the best value definition of acceptable residual capabilities in the downsized base, competition for competition's sake does not necessarily meet requirements to

shape the base through carefully crafted procurements. Competition should be structured for best value.

- We should recognize that with a monopsony, wherein there is only a single buyer (as exists with the defense industry) there are special obligations on the part of DoD to provide long-range vision, leadership and case-by-case acquisition strategies to support that vision.

ACRONYMS

AAWS-M - advanced antitank weapon system-medium

ADPA - American Defense Preparedness Association

AFAS - Advanced Field Artillery System

AHIP - Army Helicopter Improvement Program

AMC - Army Materiel Command

ASM - Armor System Modernization

ATACMS - Army tactical missile system

AUSA - Association of the United States Army

C2 - command and control

C3I - command, control, communications and intelligence

COCOM - Coordinating Committee on Multilateral Export Controls

DMR - Defense Management Review

DoD - Department of Defense

DU - depleted uranium

EDA - excess defense articles

FAR - Federal Acquisition Regulation

FARV-A - future armored resupply vehicle-ammunition

GFE - government-furnished equipment

GMR - graduated mobilization response

HASC - House Armed Services Committee

HIP - Howitzer Improvement Program

IMIP - Industrial Modernization Incentives Program

MSE - mobile subscriber equipment

MANTECH - Manufacturing Technology Program

NDI - nondevelopmental items

O&M - Operations and Maintenance

P3I - preplanned product improvements

PCB - printed circuit board

R&D - research and development

RDT&E - research, development, test and evaluation

RFP - request for proposal

SASC - Senate Armed Services Committee

TACOM - Tank Automotive Command

TDP - technical data packages

THAAD - theater high altitude air defense

CONTENTS

U.S. DEFENSE INDUSTRIAL BASE PREPAREDNESS

SECTION I: INTRODUCTION

The move to restructure the U.S. armed forces in the post-Cold War era poses many challenges, one of the most significant of which is to rationally reduce the defense industrial base without rendering it unresponsive in future crises.

The national strategy to address the changed world environment lays out the requirements for military forces and, by implication, U.S. industrial base support for these forces. The severity of the cuts in defense acquisition will, under the current funding strategy, challenge the capability of the base to produce modern weapon systems for U.S. forces. Without greater consideration for the impact of future defense budgets on the industrial base, U.S. forces may lack the means to execute the national strategy against a future enemy.

While U.S. industry expresses concern for their ability to support the defense establishment in future years, many claim that industry rose to the challenge during Desert Storm and can do so with alacrity the next time they are called upon. But a myth surrounds Desert Storm. Industry did indeed respond, but with commercially manufactured products. Their great successes were chemical suits, meals-ready-to-eat, desert camouflage uniforms and desert boots. Accelerated production of the Patriot PAC II and Army Tactical Missile System (ATACMS) occurred because long-lead-time items had already been ordered and delivered to the plants for assembly. This surge was a fortuitous confluence of events. But no other significant major production surge of major weapon systems took place that influenced the buildup and the war over the seven-month period. In essence, Desert Storm was a "come as you are" war fought with existing manpower, equipment and stocks of supplies. It is likely that such will also be the case in future military contingency operations.

A window of opportunity exists now in the debate over defense policy and strategy to influence the future defense industrial capability of the nation. The essential question is: How can we reshape a defense industrial base to provide technologically superior, affordable weapons within austere defense budgets in the future?

Before continuing this discussion of the defense industrial base, it would be useful to provide definitions of certain key terms that appear throughout the paper:

Defense Industrial Base. All government and privately owned plants and equipment, as well as government and private technology development efforts.1

Surge. Ability to accelerate production of needed items to satisfy various contingencies, using peacetime priorities, allocations, authorities, and existing facilities and equipment.2

Reconstitution. Capacity for timely expansion of air, ground and (to a lesser extent) maritime forces in the aftermath of reductions from

relatively high force levels.3 This includes the ability to generate wholly new forces as a hedge against a reemergent global threat to the United States.4

This monograph discusses the current national security strategy and its implications for the industrial base, to include the state of selected industrial base sectors and recommendations to improve the ability of the industrial base to support the strategy.

The paper was based on a series of closed-door seminars on the subject with industry and government leaders and selected experts from other associations and academe. The initial thrust was on Army issues and concerns, thus the prevalence of Army examples throughout the monograph. Overall observations, conclusions and recommendations, however, are defense-wide in their scope. The monograph is a joint effort of AUSA and ADPA.

SECTION II: PRESENT INDUSTRIAL BASE STRATEGY

Strategy and the Role of Defense Industry

President Bush articulated a new national security strategy at Aspen, Colorado, on August 2, 1990. Although lost in the excitement of the Iraqi invasion of Kuwait that same day, and the ensuing march to war over the next seven months, it laid the foundation for the subsequent Presidential National Security Strategy of the United States in August 1991, and for development of an implementing national military strategy.

The new strategy calls for continuation of the capability to deter strategic war and defend critical U.S. interests, while introducing the new strategic concept of reconstitution. Reconstitution allows for reductions in military forces while planning and preparing for their expansion in the event of a future global threat to U.S. interests. The president describes the international situation as a more complicated, more volatile and less predictable world. He draws an analogy to the 1920s when, without a great threat to U.S. interests, the nation turned inward and abandoned its military might, only to have to regenerate it 20 years later.5

The derivative national military strategy contains four tenets -- strategic deterrence and defense, forward presence, crisis response and reconstitution. In each case, success of the U.S. strategy depends upon technological superiority to offset quantitative as well as any qualitative advantages of a potential enemy, reduce risks to U.S. forces and enhance the potential for early termination of hostilities.6 To effectively implement the military strategy, Defense Secretary Cheney described the need in future years for "vigorous defense research and development, the fielding of advanced military systems as soon as necessary, and the preservation of critical elements of America's defense industrial and technology base."7

For the Army, particular concern focuses on the needs of forward presence and crisis response forces -- those which will be committed early to combat. The chief of staff recently affirmed that the key to maintaining an edge in warfighting is the balanced integration of high quality personnel, capable equipment and competent doctrine. He emphasized ensuring technological superiority in the decade ahead.8

Implications of the national strategy for the industrial base are significant. The U.S. Congress Office of Technology Assessment identified in a study last year four tasks for the defense industrial base:

1. Sustain U.S. forces at war.

2. Develop and produce high quality defense material.

3. Enhance deterrence by the perceived capability of the United States to mobilize its technology and industrial strength for rapid production of new military systems.

4. Support allies and friends.9

Industrial Base Requirements

The national strategy challenges the industrial base to continue to create weapon systems which are technologically superior to those of potential enemies. This will be even more important at lower levels of forces and funding. Further, maintaining a margin of superiority will become increasingly difficult as access to advanced weapons spreads and the U.S. industrial base shrinks. U.S. forces could face high technology weapons even in regional contingencies.

The Army strategy parallels this notion "to assure U.S. combat capabilities overmatch those of potential adversaries." Plans incorporate the integration of new systems, improvements to current systems, and procurement of nondevelopmental items to create the overmatch.11

Throughout recent discussions DoD officials have noted a need for technology insertion and evolutionary change in fielded U.S. weapon systems. Indeed, technology is changing so fast, on average doubling in capability every three years in the electronics field, that without planned evolutionary change, systems could face rapid obsolescence.

The second requirement of the national strategy is the ability to support crisis response forces in regional contingencies. However, this requirement has received scant attention.12 Except in some government-owned, contractor-operated facilities, little surge capability exists. Maintaining such capacity, however, is only useful when long-lead items have been procured and stocked in anticipation of accelerated production of major end items or components. Surge can, however, meet demands for some consumables, commercial-type items primarily, and spares in a contingency, but forces will rely upon existing stocks for the majority of their support. Keeping production lines warm to assure a surge capability entails exceptional costs if the products fill no current demand and funds will not exist in the future to maintain inefficient capabilities.

Reconstitution represents the third, and perhaps most difficult, major requirement levied on the industrial base by the strategy. The strategy declares, "We must have the capability to generate wholly new forces should the need arise." Retaining the ability to reconstitute will require investment in "hedging options whose future dividends may not always be measurable now."13 This ability represents not only a means to expand a smaller force to meet new global threats, but a means to deter aggression by signaling U.S. will to fulfill its responsibilities regardless of cost. Hedging options could include laid-away production facilities, stockpiling critical materials, preservation of critical elements of the industrial base and investments in basic science and high-payoff technologies.14

Ignoring reconstitution because of its inherent costs carries recognized risks. Admiral David Jeremiah, vice chairman of the Joint Chiefs of Staff, explained in testimony to the Senate Armed Services Committee that "the industrial base itself is virtually impossible to reconstitute in a timely fashion if it is allowed to completely wither away."15 This view is in contrast with the views of other DoD officials who described a reconstitution strategy for Army forces as the storage of surplus equipment from the current drawdown and reissue of this equipment to newly created units when and as needed for future force expansion.

While recognizing that this equipment could be technologically inferior in five to 10 years, alternatives were considered too costly.

Research, Development and Acquisition

The defense strategy for development and acquisition of future systems is founded on a new concept. This approach supports research and development of new technologies and development of limited prototypes for test and evaluation, but avoids serial production unless necessary to meet a specific requirement and it is concurrently cost effective to do so. The research focus seeks some evolutionary changes to existing weapon systems, development of innovative, highly leveraged breakthrough technologies and insertion into existing systems, and development of "technology trump cards," to be played every 10 years or so, to sustain the long-term technological dominance of U.S. weapons.16

The new acquisition system would include concurrent engineering of new technology prototypes to allow preparation of detailed manufacturing plans prior to putting the prototype system on the shelf, to be produced in mass in an emergency or as a point of departure for future new systems. However, these systems would not normally proceed to full scale development and production, avoiding costs associated with tooling, training and facilitizing for serial production, the most expensive phase. By delaying or avoiding it, DoD can conserve scarce acquisition funds and thereby fund a larger number of critical research, development, test and evaluation (RDT&E) programs.

Historically, however, transition from development to production has encountered enormous difficulties and time delays to work out problems with manufacturing techniques, quality control and systems integration. The Army effort to produce the "Big Five" in the late 1970s and early 1980s, for example, faced all of these difficulties and resulted in design changes to facilitate production, delays in fielding and, initially, poor quality. Representative Les Aspin, chairman of the House Armed Services Committee, who has advocated a "rollover" system for technology development similar to that being adopted by DoD, acknowledges the pitfalls of this approach and recommends an expanded rollover as well as selective low-rate procurements to keep vital, defense-unique capabilities operating.17 This would reduce the risk of losing production capabilities in entire sectors and ease production problems with new systems when required.

While maintaining a robust technology base, DoD proposes to maintain limited production capacity in critical areas by laying away facilities against potential future needs. Experience indicates, however, that layaways are a low priority for funding. In fiscal year 1989, the Army reported that maintenance of laid-away ammunition production lines, worth over $8 billion, was underfunded by 55 percent and was even worse in fiscal years 1990 and 1991. Such underfunding has severely constrained the ability to surge or reactivate ammunition production facilities in support of all services and will result in total loss of the laid-away base if left uncorrected.18 The prognosis for protecting laid-away facilities for other commodities, which will likely have an even lower priority than ammunition, is bleak given the inability of the Army to fund manpower, readiness and modernization at desired levels over the next decade.

Loss of skilled manpower, deterioration of machine tools and introduction of new manufacturing process technologies contribute to the difficulty of successfully executing a usable layaway program. Also, the question could be raised whether preserving the production means for old technology products and processes is a prudent expenditure.

Graduated Mobilization Response

Tied to the reconstitution strategy, DoD has adopted a graduated mobilization response (GMR) strategy to mitigate the impact of a crisis and reduce lead times associated with mobilization. GMR initiatives are categorized as preparation and planning, crisis management, national emergency and war. GMR is an effort to address the reduced responsiveness of a smaller, less diverse industrial base of the future.

The assumptions inherent in GMR are illuminating. First, conflict does not occur for at least 24 months after initiating GMR measures. This assumes political authorities will recognize the threat and decide early to act in a timely manner prior to the outbreak of hostilities. Further, GMR assumes equipment in storage has been maintained, only available production facilities are used, production capabilities do not relocate (thus delaying start-up), and funding is unconstrained.19

Once plants are closed, the 24-month assumption means almost no new production of any kind would contribute to the warfighting capabilities of U.S. forces. The Joint Chiefs of Staff affirm this, saying it would take two to four years to restore production to 1990 levels if facilities had gone cold, and even that assumes some layaway of capability.20

Free Market Assumptions

The DoD industrial base strategy conforms with the administration's free market philosophy. Eleanor Spector, Director of Defense Procurement, reiterated that point clearly: "The philosophy of the department is not to interfere with the operation of the free market. We will not attempt to determine the appropriate size of the defense market ... and we will not ... factor in the consequences of the selection of a contractor for the overall structure of the industry."21 Deputy Secretary of Defense Donald J. Atwood has spoken similarly on several occasions.

The difficulty in this approach resides in the assessment of the U.S. defense industry as a free market. A free market is defined as one with many suppliers and many buyers. The defense industry is not, in fact, free; it is a monopsony. The U.S. defense market has many suppliers, but only one buyer -- the Defense Department; that buyer establishes the requirements, establishes the risks, determines the size of the market and selects winners and losers. DoD, in concert with other agencies, establishes the policies, rules and regulations for the defense industry. Even exports are controlled in large part by DoD, either through its own management arm, the Defense Security Assistance Agency, or through controls and cost accounting procedures on the foreign sale of U.S. developed weapons.22

Defense Trade Potential

Defense trade could be an important component of U.S. defense industry policy but faces challenges from conflicting and overlapping jurisdictions, U.S. policies and laws in opposition to expanding arms sales, and lack of unified policy definition and direction. Current arms control regimes, enhanced proliferation control, the missile technology control regime, the Middle East arms limitation agreements and the Coordinating Committee on Multilateral Export Controls (COCOM) further limit the ability of U.S. defense companies to sell in the international marketplace. Add to this unilateral technology transfer restrictions, the national disclosure policy, and congressional limitations and notification procedures. Differences between the Departments of State, Defense and Commerce complicate issues for U.S. businesses. Finally, a bias against selling arms affects the national mentality.

Recent discussions of overseas arms ventures have concentrated primarily on prospects for codevelopment and coproduction agreements to reduce costs, share technology and develop a larger demand for production.23 However, studies of European consortia reflect higher costs from multiple overheads, longer development and fielding times, and smaller markets than anticipated. Size of the U.S. defense industry alone intimidates possible participants in joint ventures who fear losing their proprietary rights to the larger, more capable U.S. firms.

Despite these concerns, defense trade has expanded significantly over the past three years, and a far greater potential remains. Benefits to U.S. jobs, balance of payments and national income are important. The potential for foreign sales to sustain warm production lines during the period between final domestic buys and future modernization cannot be ignored. Keeping facilities open allows continued modernization of process technology, rapid adaptation for new technology production and retention of critical engineering and production skills.

Deputy Secretary Atwood decried excessive controls in a recent speech, saying "the unimpeded transfer of technology and products is essential if we are to have the industrial and technology base necessary to guarantee our collective security into the next century."24 The U.S. Congress Office of Technology Assessment asserts that controls are no longer necessary, having been obviated by the worldwide diffusion of defense technology and global political changes.25

The United States participates in the Coordinating Committee for Multilateral Export Controls (COCOM). Last year COCOM reduced by two-thirds the licenses which industry is required to obtain prior to exporting arms. In other cases, more liberal procedures for requesting exemption have been applied, significantly freeing trade restrictions. The current COCOM core list as implemented by the U.S. Department of Commerce contains eight categories of technologies and goods considered critical or which could contribute to nuclear or biological proliferation. Despite positive changes to the COCOM core list, U.S. unilateral export controls continue to impede progress. Criteria for application of export controls are ambiguous, and agencies overseeing them have overlapping jurisdictions. This allows many offices to deny export licensing to U.S. firms for specific products, despite the fact that these items are freely available outside the United States.26

U.S. controls increase the difficulty for U.S. companies operating in the international marketplace. Competition from the European Community (EC) consortia jeopardizes past penetration of the large European market by American firms. Recent EC action to establish common standards and test and certification procedures could adversely affect U.S. ability to export defense items.27 In the Pacific Rim, nations are experiencing rapid economic growth and challenging the competitiveness of U.S. industries in the electronics and armaments markets. Both regions have demonstrated the ability to achieve technological and quality equivalence in some sectors with U.S. products. In both regions, large commercial conglomerates produce defense products as only a small part of their total production, providing them flexibility and resilience in a changing world market. This has been particularly notable in the export of dual-use products where the U.S. functions at a distinct disadvantage to Japan. "The United States appears to be alone among advanced industrial nations in its rigid institutional and legal separation of the production of military and civilian technologies. Department of Defense regulations make it extremely difficult for a large company to organize itself to produce military materiel and consumer products under one administrative roof."28

Foreign competitors of U.S. defense companies have generally greater cooperation with and assistance from their own governments. Guaranteed government loans to buyers have become a normal means of financing large defense purchases from U.S. industrial competitors. U.S. companies lack such loan guarantees, and a recent administration effort to create $1 billion in loan guarantees through the Export-Import Bank for strong U.S. allies, NATO, Japan, Australia, New Zealand and Israel, failed in Congress. Without such loans, U.S. companies will continue to operate at a disadvantage overseas.

Other U.S. policies affect competitiveness overseas as well. A cable from Deputy Secretary of State Lawrence Eagleburger for all ambassadors and charges d'affaires worldwide, titled "Guidance Concerning Embassy Role in Support of U.S. Defense Exporters," directs increased cooperation with U.S. businessmen in developing overseas markets.29 However, consistent support for U.S. businesses encounters barriers in the historical bias in the Foreign Service and Congress against arms sales and in strong lobbies against export to certain countries.

The Excess Defense Articles (EDA) program offers foreign nations defense materiel excess to U.S. needs at a small fraction of their value. Frequently, the transfer of older, usable equipment raises difficulties for foreign buyers with requirements for training, documentation and spares, but also reduces the market for commercial sales of newer equipment. While lesser quantities of new equipment would be purchased, readiness and capability of foreign militaries would increase and the economic position of U.S. firms would be improved. EDA may, in fact, handicap U.S. companies because it is older and less reliable and spares are so difficult to obtain. The unavailability of this materiel tarnishes the U.S. reputation for high quality equipment and encourages buyers to seek other sources.

Finally, U.S. defense companies have not traditionally competed for survival in the international market because the domestic market has always been sufficient. Trained marketing teams with knowledge of foreign buyers and their requirements do not exist. Companies lack overseas offices and infrastructure. U.S. systems have been designed and built exclusively for

use by U.S. forces and lack features desired by foreign nations. The enormous success of Operation Desert Storm proved the value of U.S. technology and equipment, generating greater demand for U.S. products. However, future designs will have to incorporate greater flexibility to allow adaptation for use in different environments by different forces.

The End State

The DoD strategy for the industrial base focuses primarily on defense-critical technologies, critical industries for these technologies and the linkages between the two. Increased emphasis on technology from the commercial sectors of U.S. industry and emerging international product and process technologies would supplement defense programs. This effort would leverage limited industrial base funds and help make domestic production sources more competitive in key technology areas.30

This strategy has not, however, been clearly linked with the requirements of the national military strategy. It would keep discrete sectors of the technology base healthy, while allowing the production base to atrophy. Such decisions consciously accept risk in the ability to develop and field modern systems and to integrate new technology into current systems.

The strategy developed by DoD responds to congressional concerns cited in amended 10 USC 2503 for the industrial base. Six planning and management responsibilities were assigned to the department:

1. To develop and propose plans and programs for maintaining and fostering defense industrial readiness.

2. To develop and propose plans and programs to encourage use by defense industries of advanced manufacturing processes and investments in improved productivity processes.

3. To propose the repeal or amendment of regulations and policies as may be necessary to eliminate any adverse effect that regulations or policies may have on investment in improved productivity.

4. Evaluate and propose for testing innovative ideas for improving defense industrial readiness in the United States, including ideas for improving manufacturing processes and the acquisition processes of DoD.

5. Establish and implement consolidated analysis programs to assess and monitor the worldwide capabilities and technologies critical to the national security of the United States and to monitor the defense-related manufacturing capabilities of the United States.

6. Identify the industries most important for national security applications of technologies identified in the most recent defense critical technologies plan.

Congress has continued to express its interest in what the resulting end state of the defense industrial base will be after the drawdown by holding hearings with industry and administration officials. The House Armed Services Committee Panel on the Industrial Base and the Senate Armed Services Committee Subcommittee on Defense Industry and Technology both evince great concern for the free market approach in determining the end state of the industrial base.

The administration's reluctance to choose which technologies or industries will survive avoids any implication of a specific industrial policy or philosophical benchmark. To date, DoD has failed to articulate what end state for the industrial base is desired, and the issue is still open as to what specific policies should be pursued in the absence of clearly stated goals.

SECTION III: ECONOMICS OF DEFENSE SPENDING

Defense Budget Trends

Major changes in the levels of defense spending have caused perturbations throughout the defense industry. The contractions in defense budgets in the post-Vietnam period were followed by slowly rising growth in the late 1970s and phenomenal growth in the early 1980s, reaching a peak in 1985. In succeeding years, defense budgets have declined steadily. Between 1985 and 1990, the reductions in defense spending occurred within relatively fixed and stable manpower and force structure levels. This produced compression in the research and development and procurement accounts, causing program stretchouts and some cancellations.

The impacts were not immediately apparent as the large procurement budgets of the early 1980s still provided new equipment and supplies to troops in the field. As these programs are completed, however, the pipeline will dry up. Concurrently, throughout the last 10 years, funding for research and development has remained relatively stable. Increasingly, however, cuts have occurred and are occurring in discretionary accounts, primarily procurement, as services struggle to maintain balanced manpower, force structure and readiness programs, even at lower strength levels.

In the past, a 2 to 1 ratio of procurement to R&D spending has been considered balanced, but the budget crunch has changed that thinking and procurement-to-R&D ratios are now much lower. Projections in the current five-year defense plan confirm these trends. As an example, in the Army, expenditures for procurement are projected at about $50 billion through 1995, decreasing significantly in the out-years. Meanwhile, research and development accounts remain fairly stable. However, ratios of procurement to R&D dollars decline to about 1.3 to 1, far less than a desirable minimum of 2 to 1.

DoD contends the lower funding levels will be sufficient if it can draw on a diverse industrial base that maintains technological leadership and remains efficient and productive. This is based on the premise of increased production base planning and a more flexible production capability. DoD recognizes the growing importance of technology to national power and increased competition in that realm from Western Europe and Japan. Increasingly, DoD will rely on the commercial sector to maintain technological leadership. Also, with the advances being made in flexible, integrated manufacturing processes, industry can better accommodate efficient, multiproduct, small-volume production.31 While DoD suggests that commercially developed products and processes will meet future defense demands, there is little certainty that they will be able to adequately support DoD programs.

Effects on the Defense Industry

Pressures on procurement accounts have affected the attitude and health of defense industries. Not only have budget appropriations declined, but their unpredictable nature has created a lack of confidence between government officials and industry. While budget battles are fought year to year, companies must operate on more distant planning horizons and

commit funds in anticipation of requirements. The rude economic shocks of the past several years have caused many companies to abandon the defense industry altogether, including major companies like Honeywell, AT&T and Ford, and tens of thousands of smaller firms. Modernization of older plants and capitalization of new facilities have been cancelled, while many primary contractors and subcontractors have sought cheaper offshore sources for materials and components.

The 1988 Defense Science Board addressed these effects in their study of the defense industrial and technology base. They cited a pattern of inadequate long-term investment by prime and subtier contractors as a primary cause for the increasing deterioration of the defense industrial base. Their study suggested that this lack of investment resulted from pressures for short-term returns on investment, the uncoordinated effects of the national economic and defense acquisition policies, increasing uncertainty about the defense budget and the capital markets view of the imbalance between risks and possible gains in the defense industry.32

The economic effects on the defense industry have been devastating. As a percentage of equity, defense debt was up dramatically between 1980 and 1989.

Defense Debt33

	Debt as a Percentage of Equity	
Company	1980	1989
Northrop	4 %	140 %
Grumman	85	110
Loral	20	105
McDonnell Douglas	7	95
General Dynamics	6	65
Raytheon	5	42

Concurrently, profits were down to almost one half of the Standard and Poor's 500 average. The combined effect over the past five years has driven defense industry stock values down over 40 percent. With their stocks discounted heavily, defense companies are having trouble borrowing to restructure to meet changing market demands. Indeed, many defense companies have adopted a strategy of managing for cash given their high risk, negative growth, overcapacity and low margins.34

Not all the industry's problems have been generated by the government alone. While management approaches were changing worldwide, some companies paid little attention. Their focus on quantity, not quality, good enough rather than world class, decreased their competitiveness in both performance and economy. Now faced with dramatic change, adaptation is even more difficult.

Continuing trends in defense budgeting will result in further contractions of the industrial base. While losses have occurred primarily among subcontractors and subtier suppliers, ultimately prime contractors must consolidate, convert or close. All will downsize significantly. This will exacerbate the problem of lack of competition in key sectors, but the

market will no longer support multiple primes in each sector. Of key relevance to DoD is the departure of high quality, innovative firms and the best engineering brains in the business from defense to commercial industries. Already, diversified defense companies are having difficulty retaining their best talent in the defense sectors because of the uncertainty. A Defense Systems Management College study of this flight from defense business in 1990 concluded that "without serious attention, the decline of the defense industrial base may reach an unacceptable and irreversible rate."35

Commercial alternatives for companies with insufficient defense business vary, but have not historically provided profitable venues. Defense companies target performance as a goal, not necessarily cost effectiveness nor efficiency, and they operate under a plethora of highly restrictive regulations. They have to satisfy only one customer, the Pentagon. The consequence is an inability to adapt to market conditions as they diversify into the commercial sector.36 Further, DoD procedures discourage mixed commercial-defense ventures. Diversification within the defense arena remains an available option for larger companies who can consolidate with smaller ones to bring new and innovative products and processes to DoD. However, many mixed companies may opt to divest themselves of their defense assets to concentrate on more profitable commercial business.

However the defense industry emerges in the coming decade, it will not be in the same form as past models. The historic defense industry model projects a period of research and development requiring heavy investment, followed by a relatively long production run and subsequent derivatives, both military and commercial, from the original production model, and later upgrades or modifications to original production models. Investments occur early in the R&D phase and for full-scale development and facilitization for production. Recoupment takes place late in production and for spin-off derivatives and modifications. Profits are earned primarily in these later stages of production. The new prototyping strategy discussed in the previous section implies that DoD will provide funding for development, investment and profit early to offset the loss of recoupment in subsequent full-scale production. Potentially, only sole source prime contractors may exist in some sectors to support prototyping, further complicating the notion of competition and raising the question of the applicability of antitrust laws.

As DoD projects what kind of defense industry it needs at the turn of the century, it will confront the issue of how to arrive there by free market forces. All companies in a sector are not equal, and price competition alone is not the answer. As already stated, the defense industry is not a free market with DoD being the sole buyer. Absent a truly free market, competition in this environment demands some measure of judgment in contract awards to insure the best companies survive to meet long-term demands of DoD on industry.

Defense Industrial Competitiveness

Many factors have contributed to the poor economic posture of defense industry over the past 10 years, and not all are related to declining budgets. Secretary of Defense Frank Carlucci, in his 1990 Annual Report to

the Congress, attributed industry's problems to complexities and instability of defense acquisition policies, combined with changes in trade, tax, environmental protection, and socioeconomic and foreign policies.37 The president cited a bewildering maze of DoD self-imposed regulation.38 In fact, a complex confluence of events in the 1980s, on top of unfulfilled expectations for $400 to $500 billion defense budgets, conspired to place the defense industry in a far worse position than when it entered the expansion years of the Reagan administration. The result was a "defacto industrial policy" that created disincentives to modernization, capitalization, efficiency and investment.

Use of firm, fixed-price development contracts in the past has resulted in multimillion dollar losses as companies undertook high risk programs and could not deliver within costs allowed by contract. The DoD Director of Procurement had stated that it was "generally appropriate to require fixed- or ceiling-price production options at the inception of an R&D contract for full-scale development."39 An unusually high DoD dependency on evolving and often unknown technology, coupled with huge research and development outlays, was one of the reasons for unprofitable defense business.40 Today, after the damage was done, firm, fixed-price contracts are a rarity, with review required by the Under Secretary for Acquisition for any firm, fixed-price development contract in excess of $25 million.

Changes in government policy on progress payments for work performed or products delivered have caused industry to seek high-cost loans to offset the 20 percent or 15 percent of contractor costs not paid by DoD until completion of the program. Progress payments were decreased from 90 percent to 80 percent of contract value when commercial interest rates fell in the mid-1980s. The state of defense industries now places them in a high risk financial category increasing the cost of money from commercial lenders. While progress payment rates were readjusted to 85 percent last year, companies lose profit or accrue losses when they must support through borrowing expenses otherwise attributable to the DoD.

Further impacting the industry, the Tax Reform Act of 1986 required that taxes be paid "in process" rather than on contract completion. Combined with lower progress payments, industry made up the shortfalls in borrowed money. The DoD formula for payment of contracts accounts for profit in the final progress payments and contract completion payment. Consequently, companies are paying tax on anticipated or unrealized profit, rather than on actual or realized profit. The penalties of such a system for the contractor are significant. Also, the tax reforms slowed depreciation, adding to the tax burden while decreasing minimally the corporate tax rate.

Increased competition for defense contracts resulting from the Competition in Contracting Act of 1984 was designed to lower costs as much as 15 to 50 percent by providing companies incentives to adopt cost-reducing design changes and manufacturing technologies, while increasing quality and reliability. The impact was different than expected. It created destructive competition based on low bid wins and it failed to improve quality or reliability. It placed prime contractors at risk in disseminating to industry the winner's technical data packages, allowing losers to acquire technology in contract breakouts, reduced profitability of contracts, and causing problems with system integration

and delay in deliveries. Although DoD had some flexibility in implementing the law, it chose to expand rather than restrict its use, exacerbating the negative impacts.

Other factors affecting the economic health of defense industries included the elimination of investment tax credits in 1985, extensive use of recoupment policies for recovery of nonrecurring costs in domestic commercial and export sales of defense-related materials, increased competition from depots and arsenals for repair, rebuild and upgrade of older systems; and a generally adversarial relationship between DoD and industry. The latter contributed to a degraded ability to resolve issues at low levels because the partners in the contract cannot, or will not, talk openly and freely.

A major issue in the survival of the defense industry is that of 2.7 million workers employed in private defense industries, the skills they possess, and what will become of them in the years ahead. Between now and 1995, cuts could affect more than 20 percent of the work force -- 540,000 jobs.41 Three hundred thousand workers have already lost their jobs since 1988.42 Some estimates on loss of industry jobs because of defense budget cuts are as high as one million.

Conservative estimates state that $1 billion of defense business, whether domestic or export, employs about 23,000 persons directly and another 17,000 indirectly, although estimates range as high as 60,000 total.43 One billion dollars generates a total of $1.96 billion in national income because of a multiplier effect, according to the Department of Commerce.

Since 1985, the defense drawdown has affected over 78,000 of the total 120,000 defense suppliers. Of the 78,000, about 20,000 have closed their doors and the remainder have converted to commercial activities. A factor to consider is that the defense industries represent almost 20 percent of the remaining and declining manufacturing capacity of the United States.

SECTION IV: STATE OF THE U.S. DEFENSE INDUSTRY

Enforced Competition

The defense industry comprises three major manufacturing capabilities: those that are unique to defense products, those serving both commercial and military markets, and those that meet primarily commercial demands but may also fill limited defense needs. This assessment focuses on defense-unique capabilities but examines the implications of other capabilities as well.

By limiting the need for defense-unique capabilities and expanding the acceptability of commercial-military and commercial products in defense equipment, DoD needs to focus attention on these sectors which cannot survive in the commercial marketplace.

The structure of the U.S. defense industry includes prime contractors, subcontractors and subtier suppliers or vendors. The prime contractors manufacture and assemble major systems or end items, while subcontractors build the components and subsystems which make up major systems. Subtier suppliers provide materials, such as wire, to finished products like fan motors and amplifiers. Relationships between the layers of suppliers vary and are defined by contract with the government. During the 1980s, to enhance competition, requirements for many components and subsystems were "broken out" to subcontractors and vendors under supervision of government contracting officers, a complex procedure with mixed results in terms of quality, cost and timeliness.

Breakout, which is meant to increase the number and diversity of suppliers, forces prime contractors to relinquish to the government technical data packages containing proprietary research, development and design information for use by subcontractors to "build to print" components for the prime's major system. The prime retains the responsibility of ensuring integration, quality control and timeliness of components with little or no direct control. Absent breakout, the prime will often seek offshore sources for assemblies and components where they can be obtained more cheaply with greater flexibility and where the prime can open foreign defense markets. Subcontractors, however, lack this flexibility. If the prime goes overseas for assemblies, the U.S. subcontractor loses its market.44

The industrial base contains relatively few primes. Actions by either DoD or Congress to cancel programs that would close production facilities must consider the structural impacts on the industrial base and destruction of prime contractor capability must be minimized for the national security interest of the United States.45

The discussion which follows addresses certain sectors which are of particular importance to the Army. These were directly derived from the series of seminars mentioned earlier. They are by no means all-inclusive but represent good examples of the problems and issues involved. While Army-oriented, they have defense-wide application.

Land Combat Vehicle Systems

Modernization programs initiated in the late 1970s produced the current generation of armored combat vehicles; fielding has nearly been completed for all systems. The last M1A1 tank for the U.S. Army is scheduled to roll off the production line in April 1993. Limited production of M88 Armored Recovery Vehicles and M9 Armored Combat Engineer Vehicles continues.

While the Army has 8,000 M1 tanks in the inventory, only 1,500 are the latest M1A1 version. The remainder are M1's; both are 1960s technology. The M1A2 represents the state of the art in tank technology. Technology enhancements to the M1 have made the M1A2 the most capable tank in the world, and it will be ready for serial production as early as next year.

But foreign tank technology has not lagged. The French LeClerc, the German Leopard II (Step II), the British Challenger II, the Israeli Merkava III and the Japanese Type 90 are new-generation tanks comparable to the M1A2 that are now available for fielding. Consequently, the potential exists for U.S. ground combat forces to face one or more models of these advanced foreign tanks on a future battlefield equipped only with current M1A1s. Fielded in 1985, the M1A1 technology will be dated by 1995 and deficient by the year 2000. However, if decisions in DoD prevail to cancel both the planned buy of 62 M1A2s and the conversion of existing M1 tanks to the M1A2 configuration, the M1A1 will remain the principal U.S. main battle tank well into the next century.

The cancellation of the M1A2 program will lead to closure of tank line in the future. The Saudi order for 315 M1A2 tanks and the programmed coproduction of 551 M1A1 tanks in Egypt are the only current orders that will keep the U.S. tank production base alive unless there is a major M1 upgrade program. While other foreign sales prospects exist for M1A2 tanks, they could evaporate with the U.S. decision not to field an M1A2. If the Saudis were to cancel their order, and no M1 upgrade programs were authorized or funded, a closure of all U.S. tank facilities could take place as early as 1993. Closure of the government-owned, General Dynamics-operated tank facilities would also affect manufacture of government-furnished equipment (GFE) at Watervliet and Rock Island Arsenals.

With closure would come loss of professional personnel involved in the design and development of the production phase; then, in stages, of critical fabrication skills continuing through final production; and, finally, of the quality acceptance crews. In 10 years, all U.S. capability to manufacture tanks would be lost. Studies indicate that tank facilities can be laid away at a total cost of about $758 million over a six-year period, but early decisions are required to preserve the capability. Reopening production could occur within 16 months under full-mobilization (emergency) conditions or 24 months under peacetime conditions, at a cost of $1.5 to $1.7 billion.46 However, two issues arise. First, the hundreds of vendors who furnished supplies, parts and components would no longer be operating in the defense sector. A number would have gone out of business altogether. New vendors would have to be identified and certified. The inability to identify critical vendors for long-lead items could delay production significantly. Secondly, production means would be outdated,

requiring extensive skill training for new workers; the end product of this new production, an M1A1 tank, would still be outdated technologically.

One solution would be to maintain a warm production base through limited M1A2 production with conversions of the M1 to M1A2. While conversion would not exercise all vendors, it would retain critical manufacturing capabilities for expansion and later development of a new tank. At the same time DoD could create incentives to downsize to a lower economic production rate and encourage export sales.47

DoD has stated a preference for laying away portions of the base as the most cost-effective means to maintain a production capability. Their position rests upon the higher costs associated with low-volume, inefficient rates of production in existing facilities.48 Since DoD has determined that no valid requirement exists for tanks more modern than the M1A1 for the foreseeable future considering the high costs, continued production could not be justified. Secretary of the Army Michael Stone recently stated a position in favor of modernizing the Army tank fleet to an M1A1 enhanced (called M1A1 Delta) version (short of the full M1A2) if funding is available.

Army procurement of the Bradley fighting vehicle is about to end and new production is sustained only by foreign sales. The Army does not plan to build a heavy infantry fighting vehicle (IFV) based on the now defunct Armor Systems Modernization (ASM) program, so its requirement for 1,300 more Bradleys as well as the several variants for other weapon systems can be met only by keeping the production base alive. Department of the Army, Army Materiel Command (AMC) and Congress are all working to find an affordable way to accomplish that end.

BMY Combat Systems faced the present difficulties of downsizing much earlier. Their last production M109A2 howitzer for the Army was delivered in 1985. They have continued production for foreign sales and have done both the R&D and low rate initial production (LRIP) for the M109A6 Paladin. They have restructured to develop low-volume, cost-efficient techniques for the production of combat vehicles. The shift required over $80 million in capital and a significant reduction in overhead, to include engineering. Low-volume orders for the Army and foreign sales have become profitable, although BMY, like General Dynamics and FMC, will have difficulties beyond 1995 without a larger market.

Rotary Wing Aircraft

The gas turbine helicopter industry is dominated by four prime contractors: United Technologies/Sikorsky, McDonnell Douglas, Boeing and Bell Helicopter/Textron. Each shares a discrete sector of the market, making them essentially noncompetitive. Unlike combat vehicles, a commercial market exists for helicopters. It is concentrated primarily on light aircraft, but includes small numbers of medium aircraft as well. However, the total market demand comprises only 300 to 400 helicopters annually, making it too small to support the enormous research and development costs associated with this sector. Research and development for military helicopters has historically provided the means to spin-off commercial derivatives for both domestic and foreign sales.

The helicopter industry includes a number of critical technologies; some are becoming dependent on foreign sources. Precision gears and bearings are no longer produced in volume in the United States as precision machine tooling and manufacturing has migrated to offshore companies. Large forgings are still produced domestically, but the number of suppliers is dwindling. The technology of advanced composites has unique applications to military aircraft for specific shaping, high strength and low observability. Applications in the commercial sector will allow lighter, stronger aircraft, but at higher costs. Of critical concern in this sector are the systems integration technologies and skills that will atrophy if not sustained. Over one million lines of software will control the functions of the Army's new light helicopter to integrate sensors and apply artificial intelligence to the combat systems. Additional integration problems are resident in armed helicopters and special purpose aircraft, like the OH-58D with its mast-mounted sight and fire control system.

Increasing competition from European consortia, and likely from former Soviet military designs as manufacturers seek new markets, affect the viability of U.S. manufacturers. Foreign companies traditionally reach greater compromise with their clients on specifications of military aircraft allowing easier, less costly adaptation to commercial markets. The final 10 percent of advanced military capability built into U.S. systems frequently limits their commercial utility and decreases dramatically the size of the potential commercial market for the aircraft. This approach increases per unit cost and decreases profitability for private industry. In an era of shrinking U.S. defense industrial capability, DoD can ill afford to ignore the impacts of decisions on specifications on the future viability of the industry which produces their weapon systems.

In the light helicopter market, Bell continues to produce the Army Helicopter Improvement Program (AHIP) variant of the OH-58 and will retrofit some aircraft to an armed configuration. Combined with the AH-1W program for the Marine Corps, AH-1S foreign sales and sales of utility helicopters in the Middle East, Bell has a stable base until 1996. Decisions on its joint venture with Boeing to build the V-22 tiltrotor will determine future directions. Without military procurement of the V-22, costs will preclude its commercial marketing in the United States or abroad. Its unique technology places it on the leading edge, but foreign companies are pursuing similar technologies.

Production of the last AH-64 Apache for the Army was completed in 1990; foreign sales will keep this line open until 1993. McDonnell Douglas depends on retrofit of the Apache to the Longbow configuration for this line to remain viable through the remainder of the decade. Consideration by European buyers to compete the Apache against the European PAH-2 Tiger may create other opportunities, but the increasingly closed European market makes this possibility slim. Meanwhile, commercial and foreign military sales of the OH-6, MD-500 and MD-530 sustain limited production of these models.

While sales of light helicopters remain relatively stable, the profit margin on these low-cost aircraft is low. These companies are fighting just to stay in the market. Conversely, sales of medium- and heavy-lift helicopters involve high prices and profit margins but low volume. The

commercial market is particularly small because of unit costs, and military production is essential to remain profitable. Sikorsky produces the UH-60 Black Hawk (and its many variants for the other services and commercial use) and the CH-53. Orders will sustain the UH-60 lines through a multiyear contract, and the CH-53 lines are good through 1997. Boeing also manufactures heavy helicopters but is limited to conversions of older aircraft to the CH-47D variant. Their production lines can probably be supported until late 1993, but their future depends on the V-22 tiltrotor and the Comanche.

DoD procurement decisions have repeatedly cancelled the V-22 tiltrotor because, given possible alternatives, it is too expensive. The Secretary of Defense has released funding for six aircraft, but no decision for future production has been made. While this initial production run will help, research and development costs cannot be fully recovered without full production. Currently, no other future medium- or heavy-lift helicopter program is envisioned. The recent decision to delay fielding of the RAH-66 Comanche, a joint Sikorsky-Boeing program, and to produce only limited prototypes for test and evaluation, will mean future problems for these companies as well. Without either the V-22 or RAH-66, DoD will have no new rotorcraft in production or projected for production through the decade.

DoD believes that commercial and export sales will be the primary means for these companies to offset lower DoD sales and that all four primes will survive to support future defense requirements.50 This position contrasts with that of the companies themselves, who maintain that continued DoD funding is critical. Without follow-on programs, some consolidation could occur, perhaps leaving only one light and one medium/heavy prime contractor. Vendors supporting these companies will probably go out of business and be replaced by foreign suppliers, creating an undesirable foreign dependency.

Current DoD programs to sell excess U.S. military helicopters to both domestic commercial and foreign buyers (under the Excess Defense Article or 506(a) programs) undercut commercial sales and may create safety problems for older aircraft, since these aircraft lack spares packages or a sustaining base, manuals and training programs.

Missiles

The missile sector has numerous prime contractors building a wide range of missiles from antitank to air-to-air to antitactical missile defense. Existing orders for missiles will sustain production lines through 1995. However, at that point, only two Army missiles will remain in production -- the Longbow Hellfire issile for the Apache helicopter and the advanced antitank weapon system-medium (AAWS-M), the infantry antitank replacement for the Dragon. Other production lines will go cold until follow-on system requirements are identified and under contract for development and production.

The missile sector combines complex manufacturing technologies to produce precision systems, relying on electronics miniaturization, sophisticated machining processes, and munitions development skills for both warheads and rocket motors. Although designed to high engineering standards, experience indicates that production of both warheads and rocket

motors can be as much art as science. Long experimentation leads to successful mass production technologies demanding rigid adherence to manufacturing specifications. Once established, procedures rarely change. Accordingly, the consequences of closing production lines can lead to loss of critical skills and long start-up times for subsequent production.

In almost every area of missile design and development, products and processes are defense-unique. Use of commercial or dual-use technologies cannot meet demands of this sector. Although components in microwave devices, traveling wave tubes and multichip modules do have commercial counterparts, their tolerances and specifications exceed commercial ones by significant margins.

These stringent requirements create long lead times for production of critical components, generally 18 to 24 months minimum. If a production line goes cold and no components have been stocked, it would take a minimum of 18 months to restart production and produce the first missile, even if the plant had only been closed for a short time. Longer than one to two years after closing could lead to production lead times as long as four to six years. This time is needed for identification of a new supplier base, certification and product qualification. The long pole would likely be the manufacture of rocket motors, the segment most sensitive to any variability in materials or process.

To avoid lengthy delays in restart, manufacturers recommend maintaining warm production lines, even at low rates, to keep critical processes and human skills in place. Preplanned product improvements (P3I) should be integrated into warm production to continue upgrading existing systems. While all lines and companies cannot maintain current capabilities within budget limitations, careful selection of the systems remaining in production should retain the proper facilities, skills and capabilities for future needs.

The foreign market for certain missiles is good. Because of their defensive nature, air defense missiles cause little political concern with respect to regional imbalances or arms races. However, missiles with offensive missions generate significant debate which stymies sales, particularly in such volatile regions as the Middle East. Problems with technology transfer and national disclosure policies limit U.S. sales overseas, despite the availability of comparable systems from foreign suppliers.

Electronics

The defense electronics industry comprises a range of capabilities in prime contractors, from design, manufacturing, assembly and integration to only design and integration of essentially commercial components into military systems. This sector benefited from the expansion of the last decade, but like other sectors now faces grim prospects. One of the principal difficulties in the electronics industry is the constant evolution of technologies. The sum of evolutionary changes creates the equivalent of a technology revolution every 3 years, as opposed to every 7 to 10 years in other technology areas. Without aggressive P3I programs, military systems can lag capabilities available in commercial components in a short period of time.

The answer, however, may not be fully commercial off-the-shelf systems. While individual commercial components often meet or exceed defense standards, they are not integrated systems capable of providing robust C3I (command, control, communications and intelligence) capabilities to military forces. Commercial systems also evolve constantly to remain competitive in commercial markets. The computer purchased last month may be very different in subtle ways from the one purchased today, in ways that make it incompatible with a fully integrated military system. The prime's task in tying together systems involving millions of lines of software is in guaranteeing that each component operates functionally within the system parameters. Frequently, this demands continual change and adaptation to produce and field compatible systems over lengthy procurement periods.

Within the defense electronics industry, three key areas deserve attention. First, production of semiconductors for defense systems is becoming increasingly dependent on the willingness of foreign suppliers to provide both manufacturing equipment for chips and raw materials. Most semiconductors for U.S. systems are manufactured in this country using foreign materials. With semiconductors absorbing 10 to 15 percent of the cost of defense equipment, such dependence is not a minor issue. To regain lost capacity, companies must capitalize to make continuous change to their manufacturing capabilities and invest in precision machine tool manufacture.

The second area, machine tools, has seen a precipitous decline over the past 20 years, going from 120 major manufacturers in the early 1970s to eight today. In part, predatory business practices by overseas companies, subsidized by their governments, have contributed to this decline. Recent initiatives to develop new computer-numerically-controlled machine tools through the National Center for Manufacturing Systems will give U.S. companies an opportunity to regain lost ground. If the U.S. automobile industries, which must retool to survive, purchase new American machine tools, they may resuscitate this ailing industry and preserve a critical defense capability.

Finally, printed circuit board (PCB) production in the United States has dropped because of overcapacity globally and movement to offshore sources. A "dirty" industry environmentally, companies now produce PCBs in countries where controls do not restrict current "wet" production techniques. Since DoD consumes 70 percent of all PCBs manufactured, it has an inordinate interest in protecting the limited remaining domestic capability.

These areas represent challenges for both industry and DoD over the next decade, but so too does the increasingly difficult task of integrating complex C2 (command and control) systems with millions of lines of software. This argues for selected contractors being given overall responsibility for design, development, production and life cycle support. Breakout by the government of parts of the contract might so complicate the integration process that satisfactory solutions might become unattainable. Single integrating contractors can also ensure adaptation to commercial improvements in components over time.

The complex integration problems further exacerbate the difficulties DoD will have in implementing a policy of research and development followed by putting developmental systems "on the shelf" until needed. Change in the electronics industry occurs so frequently that both product and

manufacturing processes could quickly become obsolescent with such an acquisition strategy.

DoD believes that the commercial electronics industrial base can support defense requirements adequately and needs only some impetus from DoD to expand its defense activities.51 In the past, however, DoD has restricted export of communications technologies, including dual-use technologies, thus limiting the size of the commercial marketplace. Without greater flexibility and support by the Defense Technology Security Administration, the DoD technology watchdog, DoD will kill the "golden goose."52 Already, international markets are increasingly competitive, and the United States is falling behind.

Ammunition

More so than any other sector of the defense industry, ammunition is a joint venture between private industry and the government. The Army, as the DoD single commodity manager for conventional ammunition, coordinates the research and development, production and stockpiling of ammunition for all the military services with industry. Precipitous cuts in the DoD budget for procurement of ammunition and maintenance of existing and laid-away facilities have created enormous overcapacity which cannot be sustained. The private sector can produce over $4 billion worth of ammunition each year, but budgets are dropping to about $800 million annually. As in other sectors, companies must face the prospect of joint ventures, consolidations or closings. However, unlike other sectors, no commercial venue exists for these companies, and foreign sales have been marginal. In fact, foreign companies are increasingly trying to make inroads into markets which have been restricted to protect the U.S. base.

Consolidation will mean the U.S. will move to single source suppliers for many items; by 1993-1994, even these items will be filled, leaving no production requirements to support a warm production base. Critical issues for the industry are what requirements exist for future production and how they will be procured. As in other sectors, the ammunition industry contains several prime contractors and hundreds of other suppliers. In downsizing the industry, it is imperative that a package of full-service capabilities be maintained to include research and development, engineering, test and evaluation, and process technology development.

The perception that ammunition manufacture is a simple process of "making bullets" fails to appreciate the complex, high-precision processes used to produce modern rounds. Some rounds contain hundreds of finely machined parts necessary to ensure proper performance and safety in storing, handling and firing the rounds. Many have both propellants and warheads with submunitions and separate fuzing devices and options. Experienced workers and processes developed over many years are critical to production lines which must incorporate strict safety and environmental considerations.

Meanwhile, the DoD approach to restructuring this sector is to let the free market prevail. The difficulty with this approach is not having as an end state the capabilities necessary to continue a full range of R&D and production for future needs. Restart times from a cold base can be lengthy. For plants in layaway and properly maintained, production could

recommence in seven to 18 months. But last year maintenance for plants in layaway was underfunded by over 45 percent.53 For plants not maintained or to restart wholly new production, start-up times could be in excess of two to three or more years.

The sector must change in light of future DoD requirements. Issues that remain unresolved include the balance between private and government-owned industry, the extent to which flexible manufacturing can support both peacetime procurement and wartime surge on the same production lines, and what future demands will be. These issues must be settled so industry can plan their restructuring accordingly. DoD has no alternative in the private commercial sector to the capabilities that exist today. Clearly, it is in the interests of both DoD and the munition base to determine new directions and required capacities for the next decade.

SECTION V: RECOMMENDATIONS

The Defense Management Review (DMR), coming on the heels of the Packard Commission Report, lays out new directions for the acquisition community. Reforms have been undertaken to restructure the bureaucracy, streamline the process and eliminate layers between program managers and the service acquisition executives. Other reforms are intended to establish an improved balance between risk and return on investment and a better working relationship between DoD and industry. They include:

1. fully funding the development of new weapon systems to reduce long term costs;

2. establishing incentives in contracts to encourage innovation and technical advances through investment in high technology equipment and facilities;

3. creating a contractor performance review system to expand criteria for source selection and ensure DoD obtains best value;

4. reducing oversight at contractor facilities to appropriate and reasonable levels;

5. consolidating all contract administration under a single defense agency, the Defense Contract Management Command, and continued pursuit of effective contractor internal controls to reduce DoD audit requirements;

6. increasing cooperation with allies to share research and development costs.54

These initiatives are complemented by a sweeping review of the Defense Supplement to the Federal Acquisition Regulation (FAR) and revision of DoD policies and regulations on acquisition to simplify procedures and encourage procurement of commercial and nondevelopmental items.

Despite the intentions of DoD and limited progress to date, these changes encounter resistance in both application and interpretation. For example, Army Secretary Stone remarked at a Defense News roundtable on October 8, 1991, that requests for proposal (RFP) are getting simpler.55 Yet one recent report from a defense contractor indicates otherwise. In responding to an RFP, the company generated over 20,000 pages of analysis, reports and charts weighing over two tons. The bulk alone would not fit in the corporate aircraft and had to be delivered by truck to the program office.

Fault lies with the program office, DoD and the contractor. Similar to other complaints from industry about the current processes, private industry fails to raise issues to an appropriate, or sufficiently high, level for resolution for fear of jeopardizing their bids or future work opportunities. Thus, reform is stymied at mid-levels in the bureaucracy. One observer of the defense arena commented that "impediments to reform are legendary ... the reforms needed are thus basic and sweeping and must run to the very culture of our system."56

This cultural mindset will have to be overcome; otherwise, actions to preserve defense-unique capabilities of the industrial base will face insurmountable challenges. The solutions reside in three areas: reform of the acquisition process to increase efficiency and output from industry, adequate investment in critical sectors that have no commercial counterpart and improved competitiveness of U.S. industry in international markets.

Increased Efficiency in Defense Production

Measures to improve the efficiency of DoD acquisition programs target nonvalue-added costs (reported to range from 10 to 45 percent by industry), independent studies and the congressional Office of Technology Assessment. This includes not only DoD policies and procedures but actions by other agencies of government as well.57 Efficiencies have the potential to increase actual research and development and procurement efforts within limited defense budgets as well as improving the competitiveness of U.S. industry in international markets.

Dialogue. There is a great need to improve the climate of dialogue between industry and government. A more cooperative and constructive, less adversarial relationship is necessary to open lines of communication and achieve greater mutual understanding of common problems.58 Dialogue should begin early in the acquisition process to allow industry to conduct long range planning, increasingly important as companies downsize and reposition to meet the realities of smaller DoD budgets. The Army Materiel Command's advanced planning briefings to industry represent a positive step toward opening communications and creating a more cooperative environment.59 Greater detail in briefings of this nature will, over time, permit industry to make appropriate investment decisions that will provide the needed industrial capability and allow individual companies to earn a fair return on their investments.

Richer dialogue at lower levels is also essential. Relationships between contractors and government officials frequently reflect a reciprocal perception of distrust. Government officials must understand that the U.S. acquisition system, based on private industry, depends on the profit motive to create incentives for investment and innovation. Creation of a professional acquisition corps should help overcome perceptual problems and enhance communications at all levels.

The communications problem is further exacerbated by the Procurement Integrity Act. Narrow interpretations of the act by some agencies have resulted in prohibitions on discussions between contractors and government officials. This climate has inhibited understanding of the requirements and has led to confusion, false starts by industry and waste of funds. Industry should have and exercise the ability to talk to government about unnecessary and restrictive RFP requirements and "could cost" alternatives.

Other concerns for improving dialogue focus on the need to resolve differences within and between services on specifications called for in RFPs and technical data packages (TDPs). This would reduce costs to the government and allow industry to structure flexible manufacturing for low rate, low volume production. It could also enhance development of joint commercial-military design alternatives.

An example of effective dialogue to solve a critical acquisition problem for the Army is summarized as follows: The Army's Copperhead munitions program was exceeding allowable costs to such an extent that further procurement had become infeasible. In a special effort to save the program, the Army Materiel Command created six joint teams with Martin Marietta to resolve issues and identify cost saving measures. Over a six-week period, the teams were able to eliminate implied requirements and restructure parts of the program to achieve required performance at lower costs. Results of the team discussions decreased per-unit costs 30 percent initially and later another 10 percent. This allowed the Army to procure its authorized quantity.

Predictable Funding Levels. After effective dialogue, establishing stable, predictable, fully-funded programs is the most important step government can take to sustain an adequate industrial base. Without a vision of future programs and budgets, industry cannot carry out prudent planning and investment for the long haul.60 Also, without a prospect for adequate return on investment, industry cannot accept costly research and development, concurrent engineering and facilitization risks. Since DoD remains, in most instances, their only client (a monopsony) the defense industries' future depends entirely on the stability of these projections.

This requires expanded discussion with industry on future requirements and directions, more multiyear procurement contracts, and DoD and congressional commitment to sustain minimum levels of funding in defense-unique sectors over the long term.

Financial Reform. Four basic issues exist: cost accounting standards and practices, rate of progress payments, caps on independent contractor research and development, and tax credits for research and development and investment.

The increasing complexity of regulations and oversight because of abuses by a small number of contractors is strangling the industry. Government auditors require breakdowns of costs in each step of the manufacturing process, rather than commercial standards which more often capture total manufacturing costs over time to achieve a specified level of production. The mass of costing data required to fulfill government requirements incurs high overhead costs which are unaffordable in commercial ventures. This data collection requirement impedes commercial-military production on the same production lines because of high costs and forces diversified companies to create artificial barriers between their government and commercial business. Without this separation, auditors try to apply government standards to all parts of the company, unfairly penalizing purely commercial production. Consequently, government standards defeat any attempt to obtain cheaper prices by combining commercial-military production or diversifying within facilities. The standards may also keep some quality contractors out of the defense business all together.

As defense procurement budgets have declined, numbers of contracts have declined as well. But numbers of auditors and inspectors have not. The result, larger numbers of government overseers for fewer contracts, contributes to excessive oversight of the system. Simplification of government auditing standards and continued adoption by industry of

internal policing mechanisms could provide relief and achieve greater efficiency.

In 1985, progress payments accounted for 90 percent of contract costs. As interest rates changed, DoD revised the payment schedule to 80 percent in 1989 and 85 percent in 1991. This means that industry finances 15 percent of a contract's cost, tying up money that otherwise could be available for research and development or productivity investments. Further, government will not allow a company's costs in borrowing to meet shortfalls as allowable expenses because government can borrow cheaper than industry. The current policy decreases funds available to a company for discretionary investment and diminishes return on investment by the amount of the interest paid on 15 percent of contract costs.61

Combined with changes to tax laws requiring payment of taxes on a percentage of project completion rather than the earlier policy of tax payment upon contract completion, reduced progress payments impose an unreasonable burden on industry finances. As a minimum, progress payments should increase to the 90 percent level and taxes should be levied only on contract completion. Such action reduces out-of-pocket expenses for contractors and assures greater financial health of the industry.

Other tax reforms imposed in 1986 also impact negatively on industry. The current 25 percent research and development (R&D) tax credit must be enacted by Congress each year, thus precluding long-term financial planning; and it applies only to increases in R&D over the past year's level. It would now be advantageous to stop a project and start over to claim the credit, but such an approach is wasteful and marginally productive. To stimulate increased R&D requires a permanent credit applicable to total R&D expenditures.62

In addition to R&D credits, Congress should enact investment tax credits as incentives to long-term investment in industrial modernization and technological development.63 Investment in new manufacturing processes and technologies would be more attractive to industry if amortization rates were increased substantially.64 Bleak projections of future business, low ratios of profit to equity and perceptions of defense business as a high risk venture discourage investment in new, modern capabilities essential to meet future requirements for low-volume, low-rate production demands.

Initiatives to further revise contracting regulations and procedures would also enhance industry's ability to meet DoD requirements. DoD has revised and published a streamlined supplement to the Federal Acquisition Regulation (FAR), reducing its volume by half. Current efforts target the the total elimination of service supplements because they are redundant to the Defense FAR. Other acquisition policies and regulations are also under revision, but face time-consuming revisions to eliminate redundancies and assess their relative value of retention. Simplification of the Defense FAR will assist in cases where companies suffer from varying interpretations of the regulation among program personnel, auditors and inspectors within a single program. Some companies have been forced to custom-design accounting and management systems in each facility to accommodate variances in enforcement among government officials.

Conflicts also arise in application of certain regulations to greatly differing sectors of the defense industry. Shipbuilding and electronics

manufacture occur primarily in privately-owned facilities, while ammunition production is predominately government-owned. In other sectors, ownership is mixed. The inability of the FAR and Defense FAR to address unique sectors and capabilities allows wide interpretation, misapplication and confusion among government officials and industry.65

Firm, fixed price contracting. Within the limits of the FAR, recent initiatives by DoD and Congress have restricted the use of firm, fixed-price research and development contracts. But the damage to industry is has been significant. These contracts have caused industry an $8 billion loss over the past three years alone, frequently resulting in cancelled programs.66

Advocated in the early 1980s to stimulate competition and force responsible industry management practices, these contracts required exceptional levels of risk in meeting service demands for development of new, unproven technologies. Industry bore the burden of failure in these high risk ventures to develop leading edge technologies. While DoD policy and public law now require more equitable sharing of risks in development contracts, implementation lags policy. Government contracting officers are requesting bids from industry that would tie future production cost ceilings to development costs, skirting the firm fixed-price prohibition. Revised DoD policy guidance, full enforcement of existing policy and additional legislation are needed to resolve this issue.67

Competition in Contracting. Federal acquisition regulations, DoD policy and law have encouraged increased competition in industry to obtain higher quality with lower procurement and life cycle costs. In the era of defense budgets of $300 billion or more, competition made eminent sense. However, in a declining budget era, misguided competition can become counterproductive and even destructive, as firms bid on all-or-nothing contracts to survive. The danger resides in formulation of requests for proposal (RFP) that fail to consider the necessity for full-service capabilities in supporting the life cycle of a system. Consideration of best-value criteria and the desired end state of that defense sector in solicitations will prevent loss of critical industrial capabilities over the long term.

Of necessity, the downsizing and consolidations, along with the need to ensure a healthy base, will decrease some of the competitive options now used generally. These include extensive second sourcing and breakout of parts.

Also the government could move away from the requirement for Level III Technical Data Packages (TDPs) and adopt form, fit and function specifications. This would allow companies with full engineering capabilities to meet requirements with newer and better technology.68

With fewer programs on which to bid and fewer funds in programs, consolidations and mergers become inevitable. In some sectors, sufficient funding may exist to support only one full-service prime contractor. DoD should encourage and support consolidation that results in stronger, healthier firms along with capabilities in research and development, engineering, production and life cycle support. Difficulties may arise with potential antitrust considerations as firms merge capabilities and team in the development of systems and process technologies. DoD support

at the Justice Department and congressional review of antitrust policy may be required to ensure a viable defense industry.

DoD can adopt measures in contracting to counter the potentially negative aspects of monopolistic practices. These include use of procurement histories to justify costs, warranties, "should cost" computations and audits.

Life Cycle Contracting. An example of innovative contracting to ensure high quality engineering and production, lower system costs and continuous technology insertion was the Army's Mobile Subscriber Equipment (MSE) contract.

The MSE contract gives the contractor total responsibility for development, engineering, system integration and life cycle support, including development and maintenance of the system vendor base. As such, over the projected life cycle of the system, the contractor can plan for continuous R&D and technology insertion because it has total system configuration management of MSE. This allows development with a view toward preplanned program improvements (P3I) so that MSE remains state of the art in the face of rapid technology innovation. Over time, successive P3I changes could provide a significant jump in capability within the original system framework. As well, the prime contractor, GTE, can integrate commercial or dual-use components into the system to lower costs while sustaining a long-term vendor base. Without this configuration management responsibility, commercial integration to take advantage of the constantly changing characteristics of commercial equipment could not occur.

This acquisition model represents a promising means to streamline the government contracting and oversight system and reduce inefficiencies and, at the same time, guarantee that fielded equipment is modified over time to assure technological superiority of U.S. forces.

Pooling R&D Resources. Government can assist by allowing and encouraging multiagency cooperation with industry in developing innovative technologies. The National Center for Manufacturing Sciences and the National Institute of Science and Technology have programs to enhance productivity and efficiency of U.S. industry. Pooling resources with industry to investigate promising technologies until the point of bidding for specific contracts would achieve critical mass in attaining breakthroughs and share the escalating costs of research and development. Importantly, it could contribute to U.S. industry in general, regaining an edge over foreign competitors in manufacturing technologies.

Commercial-Military Integration. The commercial and defense industries have operated as parallel systems in the United States for decades because of restrictive government regulations and laws that have forced manufacturers to the extreme of establishing separate plants for production of identical goods, one for government business and the other for commercial purposes.69 But austere budgets now demand greater efficiency and such wasteful policies can no longer be condoned.

DoD must adopt procedures which encourage commercial-military integration of production of identical or similar products in the same plant. Commercial products now often meet or exceed government specifications and are sufficiently ruggedized to satisfy most military

needs. By reviewing military specifications to allow use of nondevelopment commercial equipment, DoD could lower costs and expand its potential supplier base.70 This would decrease significantly the number of defense-unique production means requiring protection to ensure future availability.

Costs could be decreased even further if DoD adopted contracting policies consistent with commercial-military integration of research and development and production facilities.71 Impediments to integration that require change to achieve efficiencies include:

1. government cost accounting system and standards: DoD policies on disclosure, cost and pricing data and audits cannot be met without adopting specific procedures unique to the DoD. Normal commercial procedures are inadequate according to defense authorities. Even when large contractors split their government and commercial business, defense auditors insist on inspecting both sides to eliminate the possibility of fraud.72

2. transfer of technical data rights to the government: When companies win bids and relinquish proprietary data to the government, the government often releases this data in subsequent bids to other companies who would otherwise not have access. The company which developed the technology loses its market advantage. While of less concern in uniquely military technologies, when dual-use technologies are released it creates a negative impact on the proprietary company's commercial viability. Consequently, some companies refuse to bid on contracts that would cause forfeiture of proprietary rights to promising technology advances.

3. unilateral change orders: Changes to specifications for, or materials ordered as, commercial items cause major cost overruns to both the government and industry. The frequency of such changes in defense contracting inhibits many contractors from crossing over to the defense side of the market.73

4. inspections: Frequent inspections and audits of contractor activities, often by large numbers of inspectors, interrupt production and management operations. Reportedly more frequent with recent cancellations of contracts, inspections and audits should be reduced to the minimum necessary to assure the government is receiving full value for funds invested. Inspectors and auditors should be reduced in numbers proportionate with reductions in the defense R&D and procurement budgets.

5. restrictions on commercial use of government-owned plants and tools: These restrictions hinder commercial-military integration by limiting availability and use of assets for commercial purposes and creating complex accounting standards for payment of rents to the government. Often rents and overhead costs for government facilities with large surge capacities exceed what a company can pay and remain profitable in commercial business. Without revision to regulations, commercial use of government facilities and equipment is not in general profitable and cannot help offset overhead costs or expand the market base.74

Incentives for Investment. Two key government initiatives to stimulate private investment in manufacturing technology development and manufacturing facilities modernization have produced positive results.

The Manufacturing Technology Program (MANTECH) provides innovative technology needed to produce DoD materiel in cases where private industry cannot. These investments reduce technical and financial risks related to transitioning programs from research and development to production.75 The program is now developing a National Defense Manufacturing Technology Plan to provide top-down guidance to the services for investment in technology "thrust areas."76 Continuation of this program will assist industry in adapting more quickly to requirements for advanced manufacturing technologies in producing advanced technology systems.

The second initiative, the Industrial Modernization Incentives Program (IMIP), is designed to increase defense contractor capital investments to enhance productivity, improve quality, reduce acquisition costs and expand the industrial base. Modernized facilities will provide greater flexibility, increased capacity and cost savings throughout the life cycle of the system.77 Originally targeted for use in prime contractor facilities, it has been expanded to include critical vendor base manufacturing facilities.

Protecting Critical Defense-Unique Sectors

Initiatives to improve the efficiency of DoD research, development and acquisition are necessary for the development and fielding of more equipment than now envisioned within smaller defense budgets. Shifting to dual-use technology development and production and acquisition of nondevelopment commercial items can achieve additional efficiencies. However, equipment for which no commercial analog exists, i.e., which is unique to military forces, must be produced in facilities designed and built for that purpose. These unique military equipment sectors cannot survive in the absence of DoD funding and trade in the international market. Special measures are required to protect them in the anticipation that they will be required to meet future national security needs. While this point has been made repeatedly in the debate on the industrial base for the past two years, there has been little recognition of this in official policy statements.

However, concern persists in Congress. The Senate expressed its views in the July 19, 1991, Senate Report on the National Defense Authorization Act for Fiscal Years 1992 and 1993, calling for greater integration between the defense and nondefense sectors and efforts to protect those elements of the defense industrial base for which there is no commercial counterpart. The House Armed Services Committee (HASC) established a Panel on the Structure of the U.S. Defense Industrial Base under the leadership of Representative Dave McCurdy to investigate the issue and propose recommended actions. The committee report dated April 7, 1992, stated that unique defense systems critical to national security should be retained.# The HASC chairman, Representative Les Aspin, has spoken out on the subject. He noted that he didn't believe present proposals would do much for the necessary industrial base, particularly the defense-unique industrial base, and provided a strawman concept for reflection by the administration.78

Others in industry and associations representing defense industry interests have called for sector-by-sector studies of the defense industry to define those unique sectors requiring DoD attention. The American Defense Preparedness Association has been most vocal, both publicly and in testimony before Congress.79

Recent remarks by DoD officials indicate a possible shift in thinking. Public statements declare that procurement decisions will consider impacts on the industrial base. While no one has as yet adopted a policy of sector analysis, pressure is building to take some action that would help determine risks in allowing market competitive forces alone to restructure America's defense industry.

The concern for sector analysis follows from the perception that "each of the major sectors of the defense industry is so dramatically different ... it is absolutely essential to obtain visibility into each of the critical sectors of the industry (in terms of their health, their innovation, their responsiveness, their competitiveness, their defense uniqueness -- both in process and products, and their foreign dependency)."81 Further, the government can shift its acquisition focus for many sectors to commercial or dual production sources (for example, components of communications systems). While this will require some changes to specifications and, in some cases, ways of doing business within the services, the cost advantages could be significant.

Sector studies would identify areas where shifts to reliance on commercial nondevelopment items or dual-use items might occur. Having defined critical defense-unique sectors, DoD could then establish minimum essential capabilities required in each sector to support the national military strategy. The great variance in sectors will make each "end state" industrial capability somewhat different. However, common capabilities would include: robust research and development, concurrent engineering, systems integration, configuration management, life cycle management (including logistics and maintenance support) and a qualified vendor base. Maintaining these capabilities would ensure retention of scientists, engineers and the skilled work force necessary to design, develop and produce future weapons.

Analysis of sector capabilities will require some assumptions about modernization and reconstitution. First, U.S. military forces will maintain technological superiority over potential enemies to compensate for numerical inferiority. This implies, in the Army's terms, continuous modernization through P3I and technology insertion to older systems while technology for more advanced systems, perhaps with leap-ahead capabilities, matures in the laboratories and proving grounds of the services. Secondly, reconstitution assumes the capability to restart production of required systems within two years of a decision, attaining fiscal year 1990 levels within two to four years. The Army would want its first new division within two years of start-up. Such time frames demand either warm or laid-away bases with a warm vendor base to respond with long-lead items. Stockpiling critical long-lead items could shorten production start-up times, but this would be a costly strategy if stocks become obsolete before needed.

Once defined, capabilities required in each defense-unique sector could be compared against capabilities generated in each sector by the

prototyping model proposed by DoD for new technology and system development. A fully resourced research and development program should support critical segments of each sector, especially scientific and engineering teams, but may not sustain engineering skills crucial to concurrent development of production processes for new technologies. Fabrication of limited, hand-built prototypes could result in unproducible technology demonstrators whose transition to serial production would be lengthy and difficult. Previous experience with prototyping indicates that components and subsystems often must be redesigned to allow for mass production. Coupled with the inevitable flow of change orders, full production can be, and often is, delayed for several years waiting for problems to be resolved.

If, on the other hand, the DoD prototyping model proceeds beyond hand-built demonstrators to concurrent engineering of systems and hard tooling for limited production to test new process technologies, a full range of capabilities in a sector can be sustained. At issue will be considerations of how much production is required to maintain vendor bases and production facilities and the degree to which prototyping can provide minimum essential levels of funding.

In the total analysis, DoD must aggregate by sector the minimum essential capabilities in R&D, procurement, modifications, upgrades, spares and operations and maintenance (O&M) required to provide balanced support for the strategy and corresponding funding levels for each sector. For comparison, assessments should be made of existing industrial capabilities and funding for them. If a shortfall exists in current capabilities and funding to meet minimum essential levels, segments of that critical industrial base sector will erode or disappear as a result. DoD must then decide whether to 1) accept risk with that sector and leave it unfunded or 2) reprioritize programs for the years in question to provide sufficient funding for critical minimum essential levels. Reprioritizing programs to achieve funding floors in sectors could entail continued low-rate production of current systems, upgrades or modifications to current systems, or expanded prototyping to stimulate more of the industrial base in that sector.

DoD should also factor into its assessments the benefits of international defense trade as supplements to DoD funding. In an era where allocation of shortages is the norm, this is both responsible and prudent. This is not to argue for unconstrained government support to arms exports, but, where it is in the nation's interest to sell arms, it can help accommodate shortfalls in domestically shrinking markets.

The methodology outlined above for assuring minimum essential industrial capability in defense-unique sectors appears preferable to protecting certain segments through the provisions of Title III of the Defense Production Act. Though under the act DoD can provide funding to sustain critical sectors for which no material requirements exist, it has failed to attain a high enough priority for funding.

DoD must apply the sector-by-sector methodology across service lines and consider the total acquisitions and the resultant impact on the industrial base. For example, in the rotary wing aviation sector all services have and are acquiring helicopters. Their procurement decisions reflect individual service needs, but do not factor in the overall defense

sector requirement. As DoD determines the minimum essential rotary wing aviation sector capabilities necessary in the industrial base to support all service needs and assesses that against current and projected funding levels, it should consider the impact of the aggregated service funding streams -- it may be underfunded or even overfunded in comparison with other crucial sectors. A total DoD perspective can clarify which needs are most urgent and set priorities accordingly.

DoD is currently focusing on critical technologies and manufacturing processes for these technologies. This research and development focus has the potential to make significant breakthroughs in important areas. But, if done at the expense of maintaining some minimum capability of full-service prime contractors with their ability to conduct systems engineering and integration, configuration management and life cycle support, DoD risks producing a truncated industrial capability which can produce brilliant components but lacks the ability to transform the new component technologies into operational systems. Only a balanced industrial capability will provide the means to develop and ultimately field advanced technology systems.

Some assessments of critical defense-unique sectors of industry for insights into possible future directions in the application of a sector-by-sector analysis follow. Note these are all Army examples, since they came from the series of special seminars cited earlier. However, the same issues and concepts apply to defense as a whole.

Heavy combat vehicle sector. With three prime contractors having full-service capabilities, significant overcapacity persists in the base. Restructuring should maintain at least one prime with the ability to support sustainment and P3I of the current inventory of combat vehicles plus the ability to perform the research and development and systems integration for the limited number of programmed new starts -- the advanced field artillery system (AFAS) and future armored resupply vehicle-ammunition (FARV-A).

Government facilities at Watervliet and Rock Island Arsenals remain critical segments of this sector and must be protected during any production hiatus. Core depot repair and rebuild capabilities are not replicated in the private sector, but complementary core functions are performed in the private sector. A proper depot-industry balance is needed for both peace and war. The Army requires both core capabilities to support its continuous modernization goal in peace and to forward deploy during war, as was done in Desert Storm.

While foreign trade may temporarily sustain the heavy combat vehicle sector, critical decision points are imminent. Upgrades to all categories of combat vehicles need to continue and there are requirements for the Bradley, derivative vehicles and Paladin self-propelled howitzers for the base force. Low rate modernization as a supplement to foreign sales appears prudent to maintain a warm production and supplier base for critical combat capabilities.

Rotary wing aviation sector. To the extent that commercial activities will support four full service prime contractors, DoD should encourage competition. However, minimum essential capabilities for joint requirements could probably be met by one or two primes. Certain critical

segments of this industry are defense-unique and require exceptional measures to protect, particularly those related to fire control, systems integration and heavy lift capabilities.

Although DoD has indicated that substantial commercial markets should support the helicopter industry, manufacturers believe otherwise. For medium and heavy lift aircraft, both procurement and operational costs exceed what most commercial users can afford. Commercial derivatives of U.S. military helicopters have designed-in safety and performance characteristics in excess of commercial needs, making them inordinately expensive options in the domestic and international markets. And no market, except foreign sales, alleviates the problem for attack helicopters. Continuation of the RAH-66 Comanche program seems a prudent measure in that respect.

New technology systems like the V-22 Osprey, which have high costs and no unique niche as yet in military capabilities, face an uncertain future in the commercial sector. The V-22 may provide a useful lesson for future development of complex, high risk systems where research and development and prototyping costs are so high that without some certain prospect of military or commercial production no firm would be willing to make the required investment. Ventures of this type may well be impossible without direct funding from DoD.

To sustain a lower cost helicopter base, DoD should enjoin those who establish requirements to constrain their demands and trade off some measure of military capability for potential commercial marketability. This would expand the market, thus lowering costs to DoD while maintaining a potentially expansible base to meet military needs in a crisis.

Missile sector. With a wide range of both prime contractors and missile types, limited redundancy appears useful and supportable. Consolidations should be encouraged where feasible to ensure healthy firms remain in business. However, low-level procurements and continuing P3I programs will reportedly sustain the sector. Development and projected production of the theater high altitude area defense (THAAD) system, Longbow and the advanced antitank weapon system-medium (AAWS-M) provide a more positive future than in other sectors.

With absolutely no commercial market, DoD must concern itself with maintaining a robust capability to meet joint missile requirements. The joint requirements are substantial and, while the services employ different technologies in target detection, tracking and guidance, many other aspects are similar. The industrial base can shrink and still meet service demands, although responsiveness and expansion in a crisis might decrease.

Electronics Sector. On the surface, this sector appears the most amenable to commercial integration. However, military demands for communications means across the spectrum in all environments, integrated with sophisticated command and control, make this sector defense-unique. To a greater extent than other defense-unique sectors, commercial components can be integrated into larger systems, but military processing demands for large-volume, secure, mobile communications exceed commercial capabilities.

Key segments of the industry on the leading edge cannot survive without DoD funding, particularly since DoD is far and away the greatest domestic consumer of certain components, like semiconductors and printed circuit boards. Perhaps the most sensitive capability rests in prime contractors who integrate entire systems for military purposes. Their ratio of engineers to skilled production workers of two to one provides a valuable insight into the nature of their work. Reassembling these integration teams and achieving comparable levels of proficiency and efficiency could take years to accomplish.

Improving Defense Trade Competitiveness

Over the past decade the United States has maintained a stable level of defense trade, averaging about $13.8 billion per year in sales through defense-sponsored foreign military sales and direct commercial sales. Post-Desert Storm sales and prospective sales have created increased opportunity to expand defense trade and maintain a larger share of the international market over the next 10 to 20 years.

Problems in developing an increased market share range from national policy to specific regulations. The administration has not established an overall policy for international defense exports, yet the industry faces increasing competition and a declining share of the market. Specific issues which require resolution include use of offset agreements in international sales, the cumbersome export licensing process, the manner in which DoD is organized to support expanded trade opportunities, disincentives to exports and surcharge policies for materiel sold through the foreign military sales system.82

Domestic considerations are relevant as well. Not only do defense exports help maintain a strong industrial base, but they also maintain a hedge against the need to rapidly expand U.S. production to mobilize in a crisis or to reconstitute. These exports also provide employment for almost one million U.S. workers and generate $27 billion in national income. This significant economic impact is not lost on Congress.

Beyond the purely economic aspects of defense sales, the foreign purchase of U.S. materiel allows the U.S. government to increase its influence over the defense policies of recipient countries. This influence derives from the training, maintenance, supply and logistics functions that accompany purchase of the equipment. Training foreign officers and soldiers, either in U.S. schools or with mobile training teams in-country, implies a certain transfer of norms and values that even when applied against greatly different cultural values propagates views beneficial to U.S. global interests. Long-term benefits can be significant.

Long-term support agreements for spare parts and logistics management services establish linkages with the military leadership of countries who purchase U.S. systems. Again, such linkages enhance U.S. influence in the country and allow some control over the level of technologies allowed into the region. Importantly, the U.S.-based infrastructure created in countries buying U.S. systems improves our ability to deploy rapidly and support U.S. forces in the region.

Impediments to expanding U.S. defense exports are numerous. Implicit in discussions of this subject is a pejorative belief that selling weapons systems to foreign nations, regardless of the attitude of other developed nations, is evil. The specter of "merchant of death" emerges, tainting rational views on the issue. Restricting exports of these weapons causes friends and allies to seek similar weapons in other markets, while arousing resentment that the United States should deign to determine policies potentially affecting the survival of their sovereign states. The negative U.S. attitude, however, shapes, in large part, congressional language on sales of weapons overseas and adds to an enormously complex, unwieldy export process.

The technology transfer argument impedes U.S. foreign sales but has become increasingly less relevant over time. The diffusion of technology is rapid and global in scope, transcending U.S. efforts to restrict access by the international market. A growing need for dual-use technologies and the heavy research and development costs involved in producing them favor fewer controls.83

The bureaucracies in the Departments of State, Defense and Commerce have hindered trade in the past, although more recent efforts at State and DoD reflect a change in thinking. Momentum to streamline procedures and provide greater support to U.S. defense industries exists. Problems still remain, however, with conflicting policies, rules and regulations within and between these agencies and the absence a single agency in charge of U.S. defense export policy and procedures.

Other factors hindering expanded trade include the lack of a loan guarantee program for the sale of U.S. articles, policy and administrative support overseas for U.S. defense industries, and adverse policies on recoupment of DoD nonrecurring costs and mandatory, high-cost, integrated life support packages

A national defense export policy implemented on a consistent basis at State, DoD and Commerce, in U.S. embassies throughout the world and in military-to-military contacts would go far to assist U.S. defense industries and their clients in securing expeditious decisions and positive support. It would make U.S. industry more competitive in the international market and protect U.S. industrial capability and jobs.

A thorough review of U.S. export control, technology transfer and national disclosure policies to allow release of U.S. developed and manufactured systems to friends and allies would place U.S. industries in a more competitive position against foreign defense suppliers. This could be accomplished prudently without serious risk of technology proliferation by complying with multilateral agreements while eschewing unilateral restrictions. Unilateral constraints harm U.S. industries and fail to limit technology proliferation because of the global access of nations to advanced technologies.

Securing U.S. guarantees for foreign purchases of U.S. defense equipment would expand opportunities for sales and achieve an equitable position with other foreign manufacturers. While some liabilities could be incurred, these loan guarantees would increase business, retain plants in operation and secure jobs for U.S. workers. The benefits would appear to offset any drawbacks of such a policy decision.

Finally, elimination of the requirement to recoup nonrecurring DoD costs in foreign sales would decrease by almost 10 percent the selling price of U.S. systems, making them more competitive. U.S. systems retain a reputation for quality and technological advances. Their principal fault is their relatively high cost compared with similar products worldwide. Revision of the law and implementing policies on recoupment would certainly contribute to expanded sales.

SECTION VI: CONCLUSION

Downsizing the U.S. military and its supporting industrial base can be accomplished. However, while the government exercises direct control over the military and can guide a rational reduction in capability, no such control exists over its industrial base underpinnings. Achieving a properly structured and sized industrial capability to meet modernization, crisis response and possible reconstitution demands planning, foresight and a dialogue with industry.

A cooperative, long-range partnership will be necessary between government and industry to accommodate changes in research and development and procurement policies and requirements. DoD is adopting new approaches to meeting future weapon systems needs, but it is not clear whether they are considering more than technology needs, while neglecting the critical but mundane relationship between technology in the laboratory and technology on the assembly line. Unless systems engineers and manufacturing engineers are involved concurrently in the development of new systems, the country will continue to develop new answers to hard issues but lack the means to produce systems quickly and responsively.

To protect the industrial capacity to put modern technology in the hands of the soldiers who must fight entails increasing the efficiency of defense production, adopting special measures to assure the survival of defense-unique production means and expanding the market base where possible to sustain production of critical weapon systems.

Efficiency is possible through improved dialogue with industry throughout the R&D and procurement process, rather than stifling discussion because of ambiguous rules. Modification of government standards to allow adoption of commercial and nondevelopmental items (NDI) and changes to contracting procedures to streamline the process, eliminating redundancy and confusion, will speed the process and lower costs.

The government must assess the industrial sectors supporting defense needs and determine which are absolutely defense-unique and essential to producing future advanced systems and how much capacity is required. Using this assessment, DoD must structure future procurement decisions to ensure survival of a minimum industrial capacity over the long term.

Finally, the administration should support and allow defense trade to the maximum extent consistent with national interests. This will protect critical industrial capacity and U.S. jobs during a period of transition in the defense industry.

Many of these considerations have been recognized and are being implemented or considered by the administration. They should continue. Others require more forceful execution and policy direction from the various departments' leadership. Still others must be addressed in the first instance and agreement reached or alternate solutions found to solve the complex problems facing DoD and industry. Proactive measures are crucial. The defense market is a monopsony. A laissez-faire approach and market forces alone cannot solve the problems of the U.S. defense industrial base.

Thorough study, policy analysis and decisions are critical to sustaining the military power of the U.S. armed forces, attained through technologically advanced systems now in the hands of our soldiers. We must not deny future soldiers the means to fight and win future battles at low cost in human life because of our inability to make the hard decisions on the future defense industrial base now.

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