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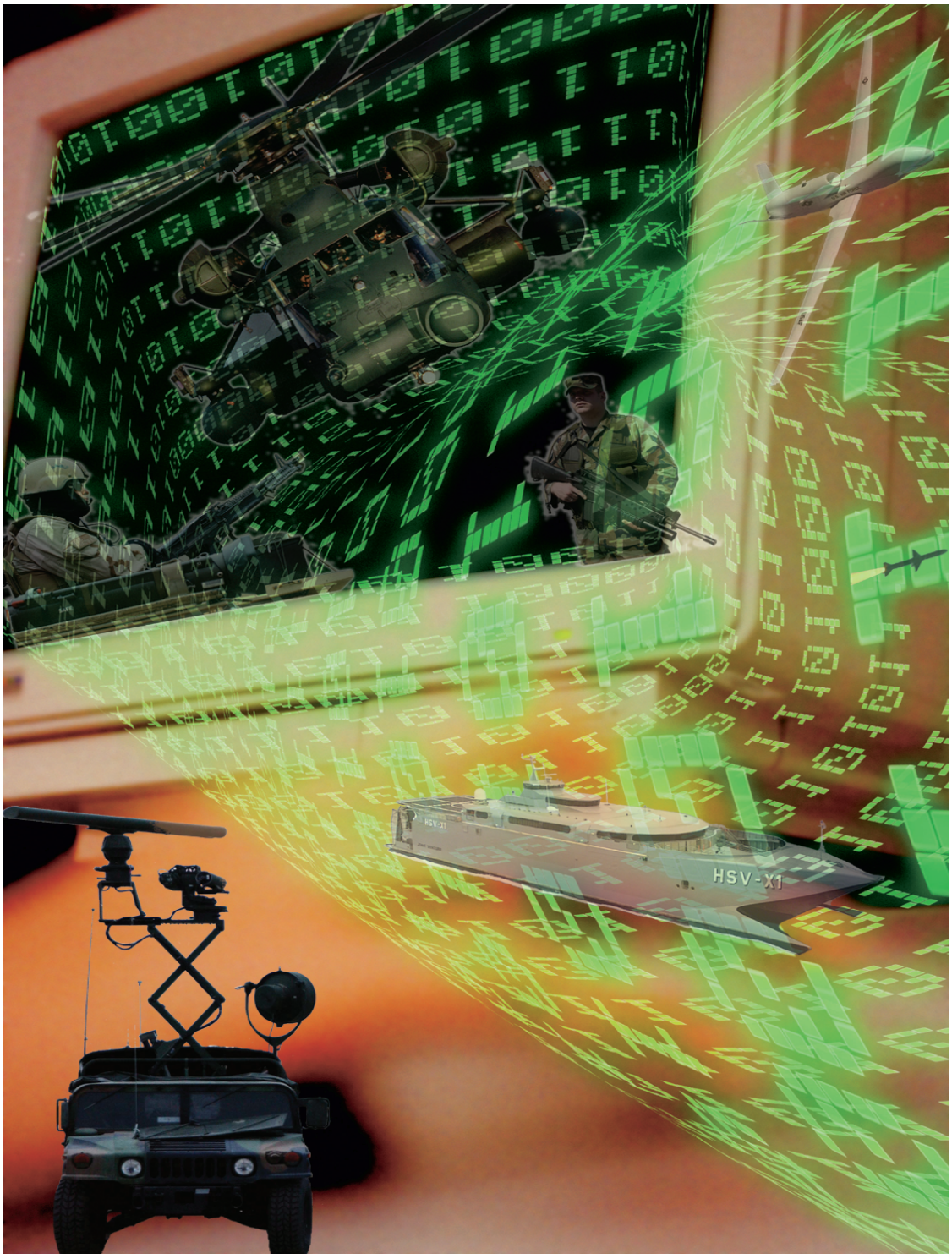
Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment



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MANAGER'S GUIDE TO TECHNOLOGY TRANSITION IN AN EVOLUTIONARY ACQUISITION ENVIRONMENT

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ACQUISITION
TECHNOLOGY
AND LOGISTICS

The Manager's Guide to Technology Transition In An Evolutionary Acquisition Environment

Acquisition excellence has changed the way the Department of Defense (DoD) designs, develops, manufactures, and supports systems. Our technical, business, and management approach for acquiring and operating systems continues to evolve. For example, we no longer rely on military specifications and standards to define and control how our developers design, build, and support our new systems. Today we use commercial hardware and software, promote open systems architecture, and encourage streamlining processes, just to name a few of the initiatives that affect the way we do business.

An important initiative is getting the latest technology into the hands of the warfighters in the quickest, most cost effective manner possible. Technology dominance is one of our key goals. Accelerating the flow of technology to the warfighter is also one the top priorities of DoD as well as the Services, defense agencies, and other key defense organizations that assist with technology transition.

This guide is the result of a collaborative effort between the Office of the Deputy Under Secretary of Defense for Advanced Systems and Concepts and the Defense Acquisition University. It is both a starting point for those new to the field and a valuable resource for those engaged in the essential business of technology transition. It builds on the work of the first edition and incorporates the most recent information on the DoD 5000 series, the Joint Capabilities Integration and Development System and the Planning, Programming, Budgeting and Execution process

We constantly strive to be of greater assistance to the DoD AT&L workforce in their quest to reduce technology transition time. We hope this guide will be a resource to help you do your job more effectively. To help us serve you, we need to hear from you. Please fill out and mail in the postage paid comment card at the end of the guide or email us at ttgfeedback@dau.mil.

Ms Sue Payton
Deputy Under Secretary of Defense
Advanced Systems and Concepts (AS&C)

Frank J. Anderson, Jr.
President
Defense Acquisition University

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PREFACE

The *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment* is published by the request of, and in collaboration with, the Office of the Assistant Deputy Under Secretary of Defense for Advanced Systems and Concepts (AS&C).

The second edition of the *Manager's Guide* incorporates updated versions of the Department of Defense's 5000 Series, Joint Capabilities Integration and Development System (JCIDS), and recent changes to the Planning, Programming, Budgeting and Execution (PPBE) process.

The Integrated Product Team (IPT) that revised and updated the *Manager's Guide* wishes to acknowledge the efforts of the original authors and the efforts of the editors at the DAU Press, without which this update would not have been possible.

We welcome your comments and questions, and encourage your suggestions on how to make the *Manager's Guide* an even more valuable resource to those engaged in the vitally important business of technology transition. Please e-mail us at ttgfeedback@dau.mil.

ACKNOWLEDGMENTS

The *Manager's Guide* is the result of a collaborative effort between the Deputy Under Secretary of Defense (Advanced Systems and Concepts), Office of the Director, Defense Research and Engineering (DDR&E); the Office of Technology Transition (OTT); and the Defense Acquisition University. It incorporates updated guidance from each of the three major decision processes in acquisition:

- DoD 5000
- Joint Capabilities Integration Development System (JCIDS)
- Planning, Programming, Budgeting and Execution (PPBE)

I would like to take this opportunity to acknowledge the excellent work of the original authors and the Integrated Product Team (IPT) which revised it. Special recognition goes to DAU faculty members Mr. Mark Lumb, the DAU IPT lead, and DAU members Mr. Dave Pearson and Dr. Bill Lukens, whose support and contributions to this revision/update were essential to the successful completion of this guide. Finally, Ms. Collie Johnson and Ms. Debbie Gonzalez of the DAU Press are to be especially applauded for their tireless efforts and contributions.

I would like to ask for your comments, suggestions, and questions to enhance the understanding of the Technology Transition process and to improve this guide so that it can become an even more valuable resource. Please e-mail us at: ttgfeedback@dau.mil.

Cynthia E. Gonsalves
Technology Transition Oversight Executive
Office of Technology Transition

INTRODUCTION

Before the war in Afghanistan, that area was low on the list of major planning contingencies. Yet, in a very short time, we had to operate across the length and breadth of that remote nation, using every branch of the armed forces. We must prepare for more such deployments by developing assets such as advanced remote sensing, long-range precision strike capabilities, and transformed maneuver and expeditionary forces. This broad portfolio of military capabilities must also include the ability to defend the homeland, conduct information operations, ensure U.S. access to distant theaters, and protect critical U.S. infrastructure and assets in outer space.

Innovation within the armed forces will rest on experimentation with new approaches to warfare, strengthening joint operations, exploiting U.S. intelligence advantages, and taking full advantage of science and technology…

— The National Security Strategy of the United States, September 2002

The National Security Strategy (NSS) highlights the dramatic changes in the security needs of our nation. The Department of Defense (DoD) is transforming to meet the challenges that it will face in the 21st century. "Taking full advantage of science and technology" is a critical aspect of the transformation. To take full advantage of Science and Technology (S&T), DoD must place the best possible technology in the hands of the soldiers, sailors, airmen, Marines, and civilians who will conduct and support future military operations.

Accelerating the flow of technology to the warfighter is one of the top priorities of the Under Secretary of Defense (Acquisition, Technology, and Logistics) [USD(AT&L)],[1] as well as the Services, defense agencies, and other key defense organizations that help transition technology. DoD is joined in transitioning technology by U.S. industry — large and small businesses, defense contractors, and companies that have not traditionally dealt with DoD.

This document, the *Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment* (*Manager's Guide*) is intended to be a source of information to promote collaboration among team members. It provides an overview of the processes, communities, programs, and challenges associated with technology transition. The *Manager's Guide* shows readers possible ways to plan ahead for their programs and areas of pursuit and, where possible, lists sources that can provide information about strategies or approaches.[2]

[1] Memorandum from the Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)) to the Secretary of Defense, Subject: Top 5 Priorities for AT&L, August 5, 2002.

[2] This document is for information only. It is not authoritative or directive in nature. Users should refer to the appropriate authoritative sources when using these processes for specific programs.

THE CHALLENGES

Keeping pace with technology and maintaining a technological advantage over our adversaries will be challenging in the 21st century because of the following three factors:

- *Technology is changing rapidly in many key areas*. The advance of technology has accelerated. Yesterday's technology may not be good enough on tomorrow's battlefield. Critical enabling technologies may become obsolescent quickly, or countermeasures may be developed.

- *Critical commercial technology will be widely available*. The lead for developing many critical technologies has shifted from the defense industry to commercial industry.

- *Our adversaries may have access to our defense technology*. Adversarial activity has extended from the battlefield into the international marketplace. Evidence shows that foreign entities are exploiting U.S. defense contractors and military research, development, testing, and evaluation facilities to obtain leading-edge research and technology. In addition, U.S. industry no longer is the leader in many areas of technology. Therefore, our adversaries may have access to many key defense-related technologies.

To respond to these 21st century challenges, DoD must not only field new technology rapidly, but also must maintain the technological edge in systems that will remain in service for decades. DoD must be able to:

- leverage the best technology available from both government and commercial sources;

- rapidly transition the technology into new materiel systems;

- refresh the technology, as needed, to maintain the advantages that our warfighters need throughout the life of a system; and

- protect sensitive leading-edge research and technology against unauthorized or inadvertent loss or disclosure.

THE DECISION SUPPORT SYSTEMS (DSSs)

Technology transition requires DoD's active involvement. Transitioning technology is a "contact sport" that requires teamwork and communication between government, industry, and eight interrelated functional communities. All must operate within the three DSSs of DoD. The DSSs are as follows:

- **The Joint Capabilities Integration and Development System (JCIDS) (formerly the Requirements Generation System (RGS))**. The system that produces information for decision makers who must determine the projected mission needs of the warfighter.

- **The Defense Acquisition System (DAS)**. The system that secures and sustains the nation's investments in technologies, programs, and product support necessary to achieve the NSS and support the United States Armed Forces.

- **The Financial Management System (FMS)**. The system that provides the resources for programs and initiatives for developing, procuring, and operating military weapons and systems. The Planning, Programming, Budgeting and Execution (PPBE) process is a major component of the FMS.

THE PLAYERS — GOVERNMENT AND INDUSTRY

Meeting the warfighting needs of the nation is a team effort, in which industry assists the government throughout the system life cycle. As the pace of technology has increased, industry has become an even more important partner in the process. The *Manager's Guide* discusses the roles of both government and industry and how they contribute to transitioning technology.

The Government Team

The government technology transition team comprises many functional components. The interrelated communities on the team discussed in this Guide are as follows:

- **Capability Needs Community** (also known as the **Requirements Community**) — The warfighters, end-item users, or their representatives who develop new warfighting concepts and outline the capabilities needed to support them.

- **Science and Technology (S&T) Community** — The scientists and managers of S&T programs who develop knowledge about the key technologies that will be needed for future equipment.

- **Research and Development (R&D) Community** — The scientists, engineers, and other professionals who have the expertise necessary to field the technologies in military systems.

- **Acquisition Community** — The program managers, product managers, staffs, and organizations that manage the development, procurement, production, and fielding of systems.

- **Sustainment Community** — The operators, program and product managers, item managers, and logisticians who operate, maintain, and improve the equipment through the decades of service that are expected of major systems.

- **Test and Evaluation (T&E) Community** — The government organizations and personnel who ensure that the systems work as intended, and are safe to operate in the challenging military operational environment.

- **Financial Community** — The government organizations and personnel who manage the resources needed by the other communities, and secure funding for the programs and systems needed to transition technology.

- **Security Community** — The intelligence, counterintelligence, security, and foreign disclosure organizations, staffs, and personnel who advise the communities about

technologies wanted by adversaries, capabilities for obtaining such technologies, countermeasures for protecting the technologies, and authorizations for transferring the technology to other countries.

The Industry Team

Like the government, "industry" is not a monolithic organization. It is a diverse group of players categorized by functional areas just like the government, with very different capabilities and points of view to contribute to technology transition. We will discuss the industry players throughout the *Manager's Guide*, but separate them into four overlapping categories when necessary to increase the clarity and focus of the discussion. The industry categories are: large businesses, small businesses, defense contractors who have a traditional relationship with DoD, and non-traditional defense contractors. All of the players are valuable sources of new technology and innovative approaches to meeting the challenges of the 21st century.

HOW THE GUIDE IS ORGANIZED

The application of technology influences the entire life cycle of an acquisition program — from identifying and using commercial and government S&T, to enabling technology trade-offs with the requirements community, to continually integrating the technology into development programs, and finally to continually upgrading the technology for legacy systems. As an evolving document, the *Manager's Guide* objectives are to help the eight government communities plan for integrating evolutionary technology and continually enhance technology by identifying the appropriate tools, business arrangements, programs, and incentives. To these ends the *Manager's Guide* is organized as follows:

- Chapter 1 — The Environment for Technology Transition — discusses a working definition for technology transition, and outlines the decision support processes that govern DoD's technology transition. The chapter identifies the communities that must interact in transitioning technology and their interests in this complex process.

- Chapter 2 — Technology Transition Planning and Tools — presents a host of tools, business arrangements, solicitation methods, and incentives for transitioning technology and implementing evolutionary acquisition. The chapter emphasizes the importance of planning for continual insertion of technology in fielded systems.

- Chapter 3 — Programs That Facilitate Technology Transition — describes a multitude of programs that are available to assist with technology transitions.

- Chapter 4 — Challenges and Considerations — builds on the previous chapters with a discussion of challenges and important considerations to help the communities at different stages in the process to transition technology and implement evolutionary acquisition.

In addition, the *Manager's Guide* presents reference materials in the following appendices:

- Appendix A — Key Resources — describes publications that address topics related to this *Manager's Guide*.

- Appendix B — Additional Web sites — offers links to online resources for more in-depth information about the topics covered in this *Manager's Guide*.

- Appendix C — Success Stories — presents information about successes in dual-use S&T, technology insertion, and technology transition; gleaned from interviews with participants in the S&T and acquisition communities.

- Appendix D — Technology Transition Planning and Pathways — contains information about the planning for transitioning technology. The Technology Assessment and Transition Management (TATM) process, an Army-developed methodology, is discussed as a generic model with other possible DoD applications.

- Appendix E — Research and Technology Protection Planning — contains information about protecting defense technology.

- Appendix F — DoD Science and Technology Career Field — contains information about acquisition career field courses offered at the Defense Acquisition University (DAU).

- Appendix G — Glossary — contains abbreviations, acronyms, and definitions used throughout the *Manager's Guide*.

- Appendix H — Bibliography — lists publications used for developing this *Manager's Guide*.

1

THE ENVIRONMENT FOR TECHNOLOGY TRANSITION

This chapter defines key terms associated with technology transition. It then provides a guide to the management systems that enable the transition process. Finally, the chapter describes the key government players involved in technology transition and highlights the increasing role played by industry.

DEFINING TECHNOLOGY TRANSITION

Technology transition is the use of technology in military systems to create effective weapons and support systems — in the quantity and quality needed by the warfighter to carry out assigned missions at the "best value" as measured by the warfighter. *Best value* refers to increased performance as well as reduced cost for developing, producing, acquiring, and operating systems throughout their life cycles.[1]

Timeliness is also important. Our warfighters must maintain a technological advantage over their adversaries. This requires compressed development and acquisition cycles for rapidly advancing technologies.

Technology transitions can occur during the development of systems, or even after a system has been in the field for a number of years. The ability to transition technology smoothly and efficiently is a critical enabler for evolutionary acquisition.

Technology transitions can occur between government organizations, such as when a government laboratory transitions a technology to a government Research and Development (R&D) organization for use in a specific system. Also, industry can transition technology to government, and vice versa.

THE GOALS OF TECHNOLOGY TRANSITION

The objective of technology transition is to meet the warfighter's requirements at the lowest possible Total Ownership Cost (TOC). To this end, the goals of technology transition are to use available resources to:

- leverage the best technology available from both government and commercial sources;
- rapidly transition the technology into new weapons and other military systems;
- refresh the technology, as needed, to maintain the advantages that our warfighters need throughout the life of a system; and

[1] Definitions in this paragraph are adapted from Deputy Under Secretary of Defense (Science and Technology) (DUSD(S&T)), *Technology Transition for Affordability: A Guide for S&T Program Managers*. April 2001.

- protect sensitive leading-edge research and technology against unauthorized or inadvertent loss or disclosure.

THE DECISION SUPPORT SYSTEMS (DSSS)

The Defense Acquisition System, the Joint Capabilities Integration and Development System (JCIDS), and the Planning, Programming, Budgeting and Execution (PPBE) process part of the Financial Management System (FMS) are DoD's three principal DSSs. These three major DSSs in the Department of Defense (DoD) guide (Figure 1-1) and enable the technology transition process and ensure that warfighters have the high-quality systems needed for modern warfare.

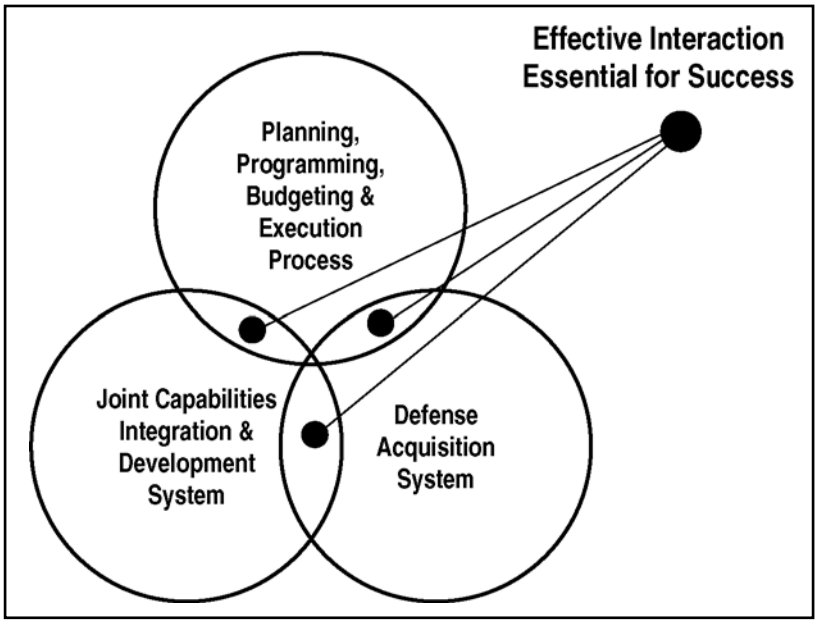

Figure 1-1. Three Major Decision Support Systems

DoD develops its vision of future warfare and identifies capability shortfalls and specific needs in JCIDS; DoD justifies, obtains, and allocates its resources in the PPBE process; and DoD develops and procures new systems using the Defense Acquisition System. These three DSSs provide the funding and management structure needed for new programs.

DoD has made major changes to all three systems to better support its future needs. DoD has revised these processes to create the maximum flexibility and agility possible to support defense transformation, while meeting its legal requirements and maintaining the necessary management controls. Much work though, remains to be done, both within the Office of the Secretary of Defense (OSD) and the Services, to develop the necessary Department-level guidance and to promulgate the new policies. Accordingly, this document reflects the latest directives and instructions.

JOINT CAPABILITIES INTEGRATION AND DEVELOPMENT SYSTEM (JCIDS)

The JCIDS, which the Chairman of the Joint Chiefs of Staff (CJCS) promulgates, provides guidance to staffs responsible for generating capability needs documents that support Major Defense Acquisition Programs (MDAPs) and other programs of special interest to the joint community. Similar programs in each Service support the JCIDS process.

Changes to the Former Requirements Generation System (RGS)
In May of 2003, the Joint Staff, as the proponent of the former RGS, announced sweeping changes to their processes to better support developing an integrated and effective joint force with the implementation of the JCIDS. Developed in close coordination with the acquisition community's improvements to the Defense Acquisition System, the newly implemented JCIDS:

- increases effective integration with the Defense Acquisition System;
- uses integrated architectures for planning and decision making;
- creates Initial Capabilities Documents (ICDs) for guiding systems development; and
- supports evolutionary acquisition.

JCIDS
JCIDS is a joint, top-down, capabilities-based approach to identifying current and future shortfalls in the ability to execute joint warfighting missions and functions. This is in marked contrast to the Service-unique, bottoms-up construct of the former RGS. It involves a comprehensive analysis of Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) in an integrated and collaborative approach to define capability shortfalls and propose solutions. The Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01D, *Joint Capabilities Integration and Development System*, provides the policy and top-level description of JCIDS. The Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3170.01A, *Operation of the Joint Capabilities Integration and Development System*, provides the details on the process of identifying, describing, and documenting capability shortfalls and their respective solutions.[2]

How JCIDS Works
The capabilities identification and assessment methodology is the foundation of the JCIDS process. It is a top-down approach beginning with the President's National Security Strategy (NSS), which is issued annually and provides the Chairman of the Joint Chiefs strategic policy and guidance. The *National Military Strategy* (NMS), which is issued as required by the CJCS and now includes the document formerly known as the *Joint Vision*, lays out the Chairman's recommendations on how to employ the military element of power to accomplish the NSS. The NMS describes the operational concepts and capabilities required of future joint forces. It provides the conceptual template for the military departments, Combatant Commands (COCOMs), defense agencies, and the Joint Staff as they plan to evolve the force to meet future operational and warfighting requirements.

Based on this strategic guidance, the Joint Staff prepares JCIDS supporting documents that refine the guidance into more detailed concepts and architectures that sponsors can use as a basis for their own JCIDS analysis.

Joint Operations Concepts (JOpsC) describe how the Joint Force will operate in the next 15 to 20 years. Joint Operating Concepts describe how the future Joint Forces Commander will plan for the employment and sustainment of Joint Forces. The Joint Functional Concept describes how a

[2] CJCSI 3170.01D and CJCSM 3170.01A are available at http://akss.dau.mil/darc/darc/html.

set of related warfighting tasks will be integrated to attain the capabilities required across the full spectrum of military operations.

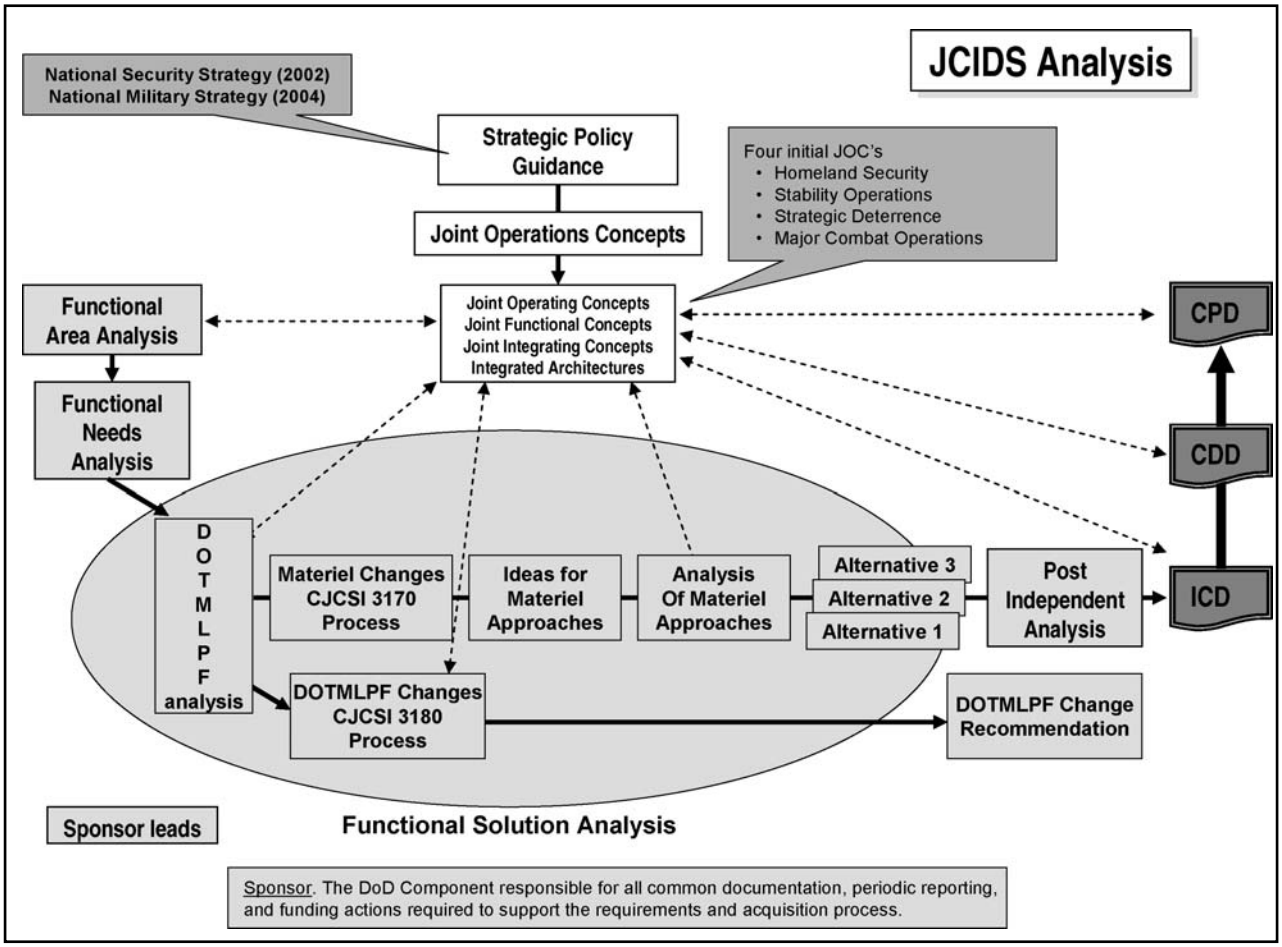

Figure 1-2. Joint Capabilities Integration and Development System

The Sponsor

In JCIDS, the sponsor is the DoD Component responsible for all common documentation, reporting, and funding actions required to support the capabilities development process. Typical sponsors of JCIDS analysis are the Army's Training and Doctrine Command (TRADOC), the Navy's Center for Naval Analysis (CNA) or the Office of the Chief of Naval Operations (CNO), the Marine Corps Combat Development Command (MCCDC), and the Air Force's various operational commands.

JCIDS Analysis, A 4-Step Process

The Operations, Operating, and Functional Concepts shown in Figure 1-2 provide JCIDS sponsors the common foundation upon which to build their JCIDS analysis to identify and document the capabilities needed to execute the joint warfighting mission.

> Step 1 is the *Functional Area Analysis* (FAA), which identifies the operational tasks, conditions, and standards needed to accomplish joint warfighting missions.

Step 2 is the *Functional Needs Analysis* (FNA), which is an assessment of the ability of current and programmed joint capabilities to accomplish operational tasks. The product of the FNA is a list of capability shortfalls.

Step 3 is the *Functional Solutions Analysis* (FSA), which is an operationally based assessment of DOTMLPF that determines approaches for filling the gaps identified in the FNA.

Step 4 is the *Post-Independent Analysis* (PIA), where the sponsor considers which integrated DOTMLPF approaches best fill the capability shortfalls. The product of the PIA is a recommendation to either effect a change in DOTMLPF or to generate an ICD to support a material solution through the DoD 5000 process.

JCIDS Documentation

Four JCIDS documents are used to support the acquisition process outlined in the DoD 5000 Series. (Refer to Figure 1-3 for a diagram of their relationship to the acquisition process.)

The Initial Capabilities Document (ICD) provides the definition of the capability need and explains where it fits into the overall joint concept. The ICD supports both the Concept Decision at the beginning of the acquisition process and the Milestone A decision between the Concept Refinement (CR) and Technology Development (TD) phases. (Refer to Figure 2-1 in Chapter 2 for a diagram of the acquisition process.)

The Capabilities Development Document (CDD) is generated during the TD phase. The CDD supports the Milestone B decision by providing detail on the proposed material solution. It also provides the thresholds and objectives for the system attributes against which the final system will be tested. The approved CDD guides the System Development and Demonstration (SDD) phase of the acquisition process.

The Capabilities Production Document (CPD) is developed during the SDD phase and supports the decision to enter the Low Rate Initial Production (LRIP) phase of the acquisition process at Milestone C. The CPD will contain refined performance metrics from the CDD based on lessons learned from the SDD phase.

The Capstone Requirements Document (CRD) facilitates the development of CDD's and CPD's by providing a common framework and operational concept for a Family-of-Systems (FOS) or System-of-Systems (SOS). CRDs are generated only as directed by the Joint Requirements Oversight Council (JROC) and will be phased out once the operational concepts upon which the JCIDS is based are fully mature.[3]

THE DEFENSE ACQUISITION SYSTEM

The general policies for the Defense Acquisition System are outlined in the DoD 5000 Series documents, which were significantly revised and reissued in May 2003. These documents describe a flexible and innovative, yet disciplined, approach for meeting technology challenges.

[3] Information on JCIDS was extracted from DAU's *Introduction to Defense Acquisition Management Guide*. November 2003, available at http://www.dau.mil/pubs/gdbks/idam.asp.

The Defense Acquisition System has changed significantly in recent years. The concept of evolutionary acquisition was introduced in the 2000 version of DoD Directive (DoDD) 5000.1 and DoD Instruction (DoDI) 5000.2, and continues to be the central concept in the 2003 version of the Defense Acquisition System.

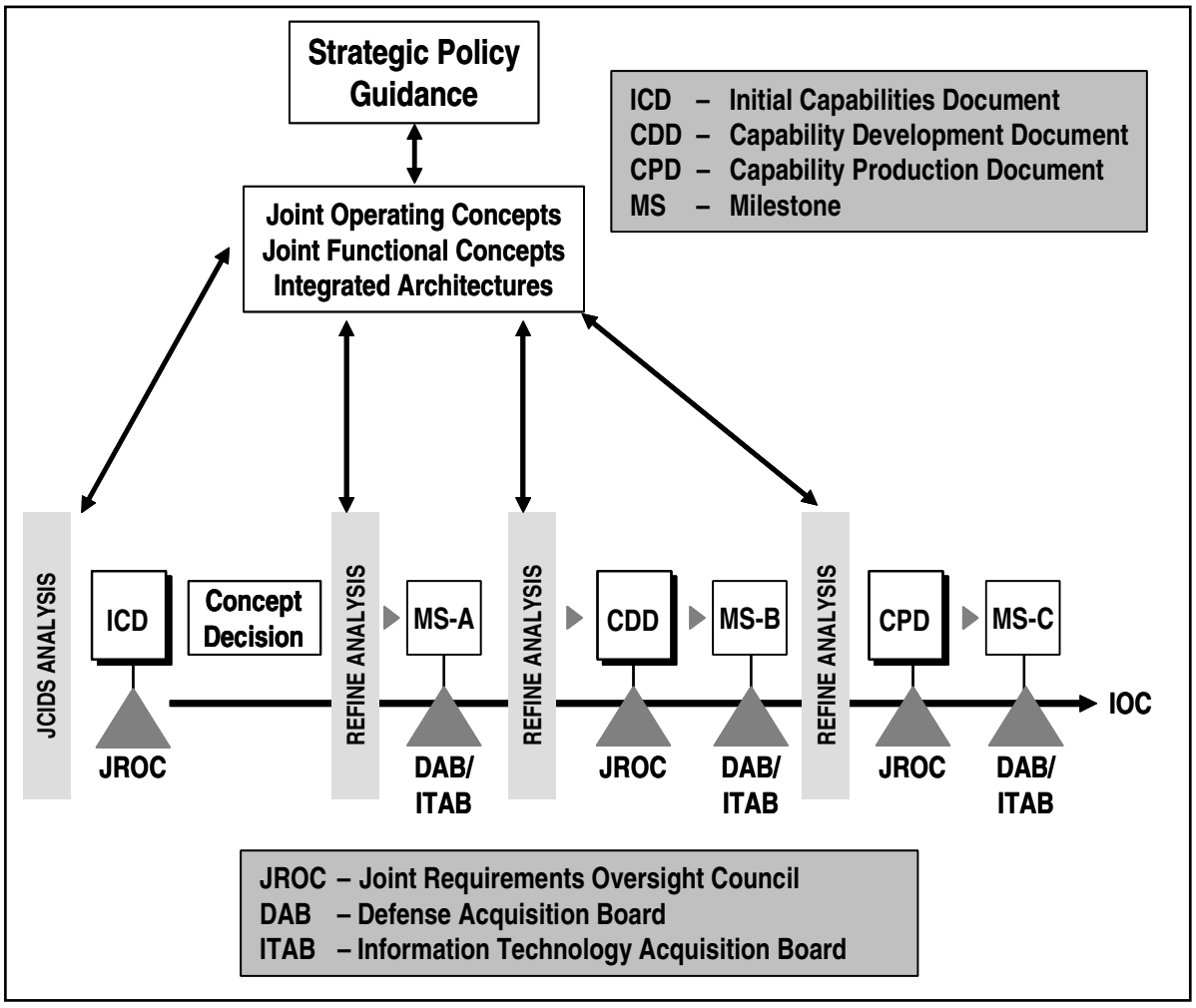

Figure 1-3. JCIDS Documentation

Evolutionary acquisition is an acquisition strategy that defines, develops, produces or acquires, and fields an initial hardware or software increment of operational capability.[4] Evolutionary acquisition is based on technologies demonstrated in relevant environments, time-phased capability needs, and demonstrated capabilities for deploying manufacturing or software. Evolutionary acquisition provides capabilities to the warfighter in increments. The capability is improved over time as technology matures and the warfighters gain experience with the systems. The first increment of capability can be provided in less time than the "final" capability. Each increment will meet a useful capability specified by the user (i.e., at least the thresholds set by the user for that increment); however, the first increment may represent only 60 to 80 percent (or less) of the desired final capability. Each increment must be tested and evaluated to ensure that

[4] USD(AT&L), "Evolutionary Acquisition and Spiral Development," Memorandum, Washington, DC: April 12, 2002.

the warfighter receives the needed capability. Each increment might also be a MDAP in its own right.

Two basic approaches are used for evolutionary acquisition. In one approach, known as Incremental Development, the final functionality can be defined at the beginning of the program, with the content of each increment determined by the maturation of key technologies. In the second approach, known as Spiral Development (SD), the final functionality cannot be defined at the beginning of the program. Each increment of capability is defined by the maturation of the technologies and supported with the evolving capability needs of the user and continuous user feedback.

Changes to the Defense Acquisition System

The May 2003 version of DoDD 5000.1 and DoDI 5000.2 promotes flexibility, common sense, and business-based decision making. These documents emphasize decentralized responsibility, tailoring, innovation, continuous improvement, technology development, transition planning, reduced cycle time, and collaboration during the acquisition process. The following are key changes in the May 2003 version of the 5000 Series:

- Close integration with the JCIDS and increased "front end" planning and analysis;
- Requirement for a new document called the Technology Development Strategy (TDS);
- Continued emphasis on evolutionary acquisition, the preferred approach for rapid acquisition of mature technology and meeting operational needs;
- Simplified and flexible management that decentralizes the responsibility for deciding about acquisitions where possible, and increases the emphasis on innovation and tailoring of programs.

The emphasis on evolutionary acquisition has been reinforced. Changes have been made to the "front end" of the process (now divided into two phases, CR and TD) to improve the alignment with the capability needs generation and resourcing processes and provide TDSs. This emphasis on increased planning early on and the additional flexibility in the system should resolve issues earlier and provide a more stable path for programs as they proceed through the process.

Left unchanged in the 5000 Series is the guidance referred to as the "Hierarchy of Material Alternatives." DoDD 5000.1 states the following:

The DoD components shall consider multiple concepts and analyze possible alternative ways to satisfy the user's need…. The DoD components shall work with users to define capability needs that facilitate the following, listed in descending order of preference:

1. The procurement or modification of commercially available products, services, and technologies, from domestic or international sources, or the development of dual use technologies;
2. The additional production or modification of previously developed U.S. and/or allied military systems or equipment;

3. A cooperative development program with one or more allied nations;

4. A new, joint, DoD Component or Government Agency development program; or

5. A new DoD Component-unique development program.

How the System Works
In Chapter 2 we discuss the Defense Acquisition Management Framework, also known as *The Lifecycle Model*, as currently outlined in the May 2003 DoD 5000 Series documents, in detail. It is the Management Framework that allows the DoD to put new and improved capabilities in the hands of the warfighters as quickly and cost effectively as possible. The JCIDS provides the capability needs that undergird the Management Framework. Once a capability need has been identified, documented, and approved, the FMS, through the PPBE, provides the resources for a warfighter's capability need to be matured from a concept on the drawing board to an actual weapon system on the battlefield.

THE FINANCIAL MANAGEMENT SYSTEM (FMS)

The third DSS is the FMS, which is designed to give DoD's warfighters the resources they need. The laws and guidance from the U.S. Congress, circulars issued by the Office of Management and Budget (OMB), and the financial management regulations promulgated by DoD establish the framework for the FMS.

Changes to the FMS
At this writing, DoD has made significant changes to its part of the financial system, the PPBE, and is contemplating further changes. The discussion below is current at the time of publication, but there may be more changes in the near future.

How the System Works
DoD relies on its PPBE Process to formulate defense budgets. The budgets are formulated beginning with a planning phase that establishes guidelines for budgets. The Secretary of Defense (SECDEF) promulgates the guidelines and also imposes fiscal limits. Next, the programming phase translates the planning guidance into specific programs, resulting in the Program Objective Memorandum (POM). POM programs must fit within prescribed fiscal limits. Final decisions are made and detailed pricing issues are addressed in the budget portion of this process. Until recently, OSD reviewed the POM and budget of each Service and defense agency separately, but in 2002, OSD began reviewing the POMs and budgets together in a combined programming and budgeting phase. The OSD review leads to the Defense budget that the President includes in his annual budget submission to Congress in February of each year.

The congressional review consists of three steps: formulation of a budget plan for the entire Federal Government, authorization of defense programs, and appropriation legislation that makes funds available. Each step can include hearings, deliberations by congressional committees, legislation that is debated by committees and on the floor of the House and Senate, and votes by the House and Senate. The authorization and appropriations phases result in legislation that must be signed by the President. Once legislation has been enacted, funds are available for spending. The funds must be spent or "executed" in accordance with an extensive set of laws and regulations.

The financial management process is lengthy and, for that reason, budgets for many different years are being considered at the same time (see Figure 1-4). For one particular budget, the set of steps — from budget formulation through execution — can take many years. Just guiding a major routine proposal through planning, programming, and budgeting that results in its enactment by Congress can require 18 to 24 months. Execution can take several more years. Changes can be made during execution through what are termed "reprogramming" actions, but such changes are supposed to be limited to emergencies and are the exception rather than the rule.

The financial process also has many constraints. The DoD financial management regulations, which document the constraints, consist of thousands of pages and impose many limits on the types and uses of funds. For example, S&T projects must be financed with certain types of R&D funds while more mature development must use other types of research funds. A weapon or system must be purchased using yet another type of funding. DoD managers have only very limited ability to shift among different funds, or "colors of money" as they are sometimes called.

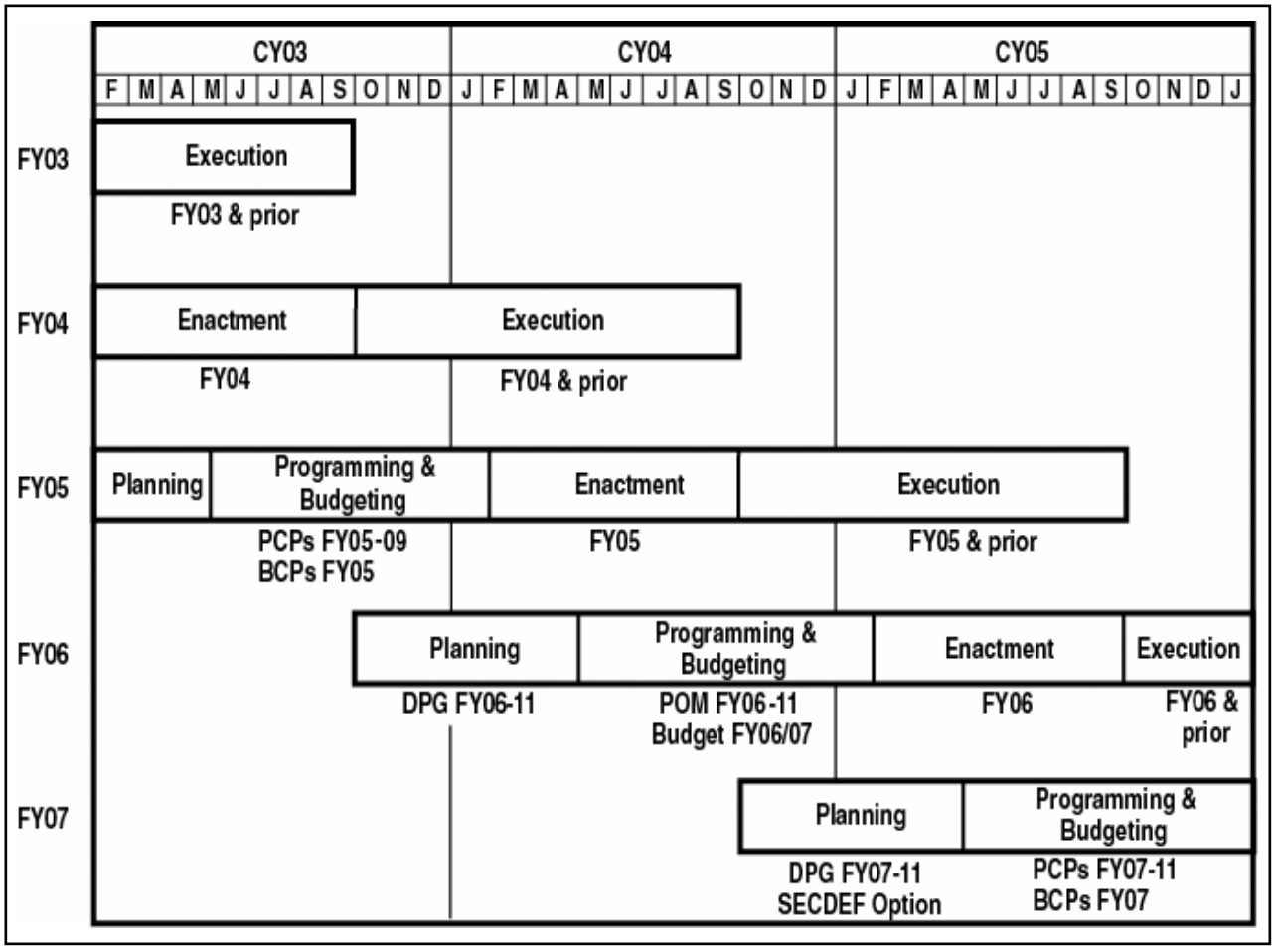

Figure 1-4. Resource Allocation Process — Overlap

This lengthy, constrained financial process poses a significant challenge for technology managers and generates some of the "transition" issues that we discuss in this *Manager's Guide*. Planning inventions two years in advance to comply with the financial process can be difficult or

impossible, especially for innovations that rely on rapidly changing technologies. Shifting funds as a program matures can make budgeting a challenge. If managers are not careful, shifting from one type of fund to another can result in a gap in funding (sometimes known as the "valley of death") that can threaten the program.

DoD is seeking increased flexibility for its acquisition managers, but many of the basic constraints in the FMS will not change. The key players from all communities, and especially those in the S&T and acquisition and financial communities, must work together to make the PPBE process work. Only if the players understand each other's challenges and communicate will they be able to encourage technology transition within the constraints of the federal FMS.

THE GOVERNMENT PLAYERS

Transitioning technology successfully requires innovative players who understand their roles and the roles of others in the process. Technology transition has many players. To focus our discussion, we have chosen eight government communities that have important roles and high levels of interaction in transitioning technology.

These eight communities are:

1. The Capability Needs Community (also referred to as "The User Community" or "The Warfighter Community")
2. The Science and Technology Community
3. The Acquisition Community
4. The Research and Development Community
5. The Sustainment Community
6. The Test and Evaluation Community
7. The Financial Community
8. The Security Community

Requirements Community, Known Now as Capability Needs Community

The capability needs community represents the ultimate user — the warfighters — in the Services and U.S. Special Operations Command (USSOCOM), that will deploy, operate, and maintain the weapons and support the systems needed for military operations. The terms *warfighter* and *user*, as used in this *Manager's Guide*, include both the organizations and personnel that conduct combat operations, the many other organizations and personnel that support the warfighting capabilities, and the personnel and organizations that represent the entire community in the defense acquisition process.

The capability needs community develops warfighting concepts for as many as 20 years into the future. Concepts are captured in documents such as the *National Military Strategy*. These documents and other "long-range" warfighting guidance provide input into the Joint Warfighting Capability Objectives (JWCOs) contained in the *Joint Warfighting Science and Technology*

Plan.[5] The JWCOs guide the planning for applied research and advanced technology development. They describe the specific performance parameters for new systems. The user community validates the military need for new capabilities. Before a new system is fielded, users participate in testing and evaluating the operation of the system to ensure that the new system is safe to use under realistic conditions and will meet the required operational need.

In the past, many Operational Requirements Documents (ORDs) established extremely challenging performance requirements that often resulted in long, high-risk, and expensive development and acquisition programs. Evolutionary acquisition uses more realistic requirements that will enable the rapid fielding of an initial capability to the warfighter, followed by new versions with incremental improvements in capability.

While the equipment is being developed and fielded, the government communities for capability needs, acquisition, R&D, and sustainment work together as a team, along with industry, to refine the details of the system and agree on trade-offs needed to make the system affordable. This teaming arrangement is institutionalized in the Integrated Product and Process Development (IPPD) Process and is discussed in Chapter 2. While a system is being developed, the capability needs community should identify the essential capabilities needed, but allow the developers the flexibility to determine how the need is met. Giving the S&T, R&D, and acquisition communities the largest possible "solution space" will enable innovation and the balancing of performance, operational, and support characteristics.

The capability needs documents (ICDs, CDDs, and CPDs) specify interoperability requirements and establish affordability objectives. Interoperability refers to the ability of systems to function in an operational environment that includes multiple U.S. military services as well as allied and coalition forces. Affordability objectives take into account the relative economic value of the capability compared with alternatives that compete for funding. One reason for establishing an affordability objective is to guide trade-offs of "Cost as an Independent Variable" (CAIV) early in the conceptual design. CAIV also can be greatly enhanced by setting goals and thresholds for most requirements and identifying critical capabilities that must be provided, as the key tenet in CAIV is to set a cost objective and hold it constant while trading off schedule and performance.

Science and Technology (S&T) Community

The S&T community consists of the government academicians, scientists, and managers of S&T programs who understand the technologies that will be needed for future systems.

The S&T community includes technology development sources, such as government labs and agencies (e.g., the Defense Advanced Research Projects Agency (DARPA)) and industry labs. It focuses on developing and understanding technologies. It should also focus on rapidly transitioning technology to affordable products and teaming with acquisition and sustainment Program Managers (PMs) to address user needs. To accomplish their goals the S&T community uses programs and processes, such as:

- Advanced Technology Demonstrations (ATDs)
- Advanced Concept Technology Demonstrations (ACTDs)

[5] DUSD(S&T), *Joint Warfighting Science and Technology Plan*. Washington, DC: February 2000.

- Joint and Service/USSOCOM experimentation
- Small Business Innovation Research (SBIR) program and
- Independent Research and Development (IR&D).

S&T planning balances the need to support future warfighting concepts with the need to support research in other areas that may produce breakthroughs warfighters have not yet envisioned. In general, S&T programs that align with specific future warfighting needs will receive the highest priority for funding.

Academia and industry are sources of IR&D as well as contracted R&D supporting DoD's S&T objectives. Increasingly, commercial R&D is of major interest to the DoD, particularly R&D in computers, software, electronics, cryptography, telecommunications, robotics, and the medical and biological sciences. To take advantage of these resources, DoD's requirements, R&D, acquisition, sustainment, and S&T communities need to stay abreast of domestic and international R&D as a market research function. They must also provide "seed money" (contracts, grants, cooperative agreements, or other transactions) to harvest and assess emerging commercial technology that may be of use to the military.

Acquisition Community
The acquisition community includes acquisition executives, Program Executive Officers (PEOs), PMs, and their staffs. In response to a validated operational capability or business need, they build or acquire new or improved weapons systems or the capabilities or services inherent in information systems.

By policy, a PM is designated for each acquisition program. The PM directs the development, production, deployment, and sustainment of a new system. The new system is created within cost, schedule, and performance constraints, as approved by the PM's acquisition executive. The PM's role is to ensure the warfighter's capability needs are met efficiently and effectively in the shortest possible time.

The acquisition community does not operate with a set plan for all systems. They interact with requirements personnel and technology providers, and develop tailored acquisition strategies that fit the needs of particular programs, consistent with the time-sensitive needs of the user's requirement, applicable laws and regulations, sound business management practices, and common sense. The current acquisition policies allow and encourage PMs to enter the acquisition process at different decision points, depending on the maturity of the concept, requirements definition, and technology. While the system is being developed, PMs work with the capability needs community to maintain a balance of cost, schedule, and performance. They can trade performance and schedule objectives to achieve the cost and affordability goals for the programs. Sometimes, new or improved technologies that will reduce costs or improve performance become available while the system is being developed. PMs should be alert to these opportunities and keep their programs flexible enough to adopt these advantageous technologies.

Research and Development (R&D) Community
The R&D community is comprised primarily of the scientists, engineers, technicians, and other professionals who have the skill and knowledge to transition enabling technologies from the laboratory to the battlefield.

The focus of the R&D community is developing and supporting technologically superior and affordable systems for warfighters. The R&D community evaluates technologies and conducts applied research; they also engineer and design candidate systems and components. The community is responsible for getting the technology to the field. Its responsibility does not end when an item is fielded. The community continues to work with the warfighters and the sustainment community as they operate and maintain the capability in the field.

The R&D community supports the acquisition community by developing systems; reducing integration and manufacturing risks; ensuring operational supportability (with emphasis on reducing logistics support during use); integrating human systems; ensuring that systems are interoperable and can interface, as needed, with other systems; ensuring that the systems are safe to use during demanding military operations; and last, but not least, giving the warfighters systems they need.

Sustainment Community
Major systems may remain in the hands of the military for 20 years or more. Maintaining these systems and ensuring that they continue to operate at the highest possible levels is the responsibility of the sustainment (logistics) community. The term "sustainment community" includes the entire range of operations and support functions. The sustainment community includes PMs, item managers, and the supply, maintenance, and procurement personnel that support fielded equipment. This community improves the reliability, maintainability, and supportability of weapons systems by updating technology and other means. The challenge is to give them the information and resources that they need to exploit technology throughout a system's life.

The sustainment community operates at the end of the cycle of introducing new technology, but should be highly integrated with other communities. The capability needs community emphasizes logistics supportability when it develops the capability needs documents for new systems. Reducing the logistics burden enables the warfighters to reduce their logistics footprint and to focus their resources on capabilities that can defeat an enemy. The acquisition community supports the logistics community by including supportability as a design factor and emphasizing logistics during the systems engineering process.

Because weapons systems are being retained longer, PMs and the logistics community are increasingly dealing with obsolescence. If systems are designed with open architectures, their lives can be extended using replacement parts or upgrades that don't require redesigning the system.

Test and Evaluation (T&E) Community
The T&E community independently assesses how well systems perform technically; how well the system fulfills documented requirements; and whether systems are safe, operationally effective, and suitable and survivable for their intended use in military operations. Two general types of testing are used: developmental and operational.

Developmental tests answer the question: does the system do what it was intended and designed to do? Developmental tests are any engineering-type tests used to verify the status of technical progress, verify that design risks are minimized, substantiate that contractually required technical performance has been achieved, and certify readiness for initial operational testing.

Operational tests answer the question: will the system give the warfighter the needed capability, under demanding military operational conditions and when operated and maintained by warfighters? Operational tests are the field tests, under realistic conditions, of an item (or component) of weapons, equipment, or munitions. Operational tests determine the effectiveness and suitability of the weapons, equipment, or munitions for use in military operations by typical military users.

The T&E community does not develop the requirements for their tests. The community obtains them from capability needs documents and other sources. Ensuring that the T&E community is part of the collaborative process used in developing systems is important. The community must have input into the process and clear and well-defined guidance about how the system is expected to perform. The evolutionary acquisition concept challenges the capability needs, acquisition, sustainment, and T&E communities to coordinate closely and continually when developing and testing "phased" programs to ensure that the T&E community is aware of what will constitute a "militarily useful increment" of capability. Only with this knowledge can the T&E community design appropriate tests.

The T&E community supports evolutionary acquisition by remaining continuously involved in the acquisition process, beginning with integrating T&E issues in the CR phase of the acquisition process. PMs can form a Working-level Integrated Product Team (WIPT) to assist with T&E issues. The WIPT should include contractor and government Developmental T&E (DT&E) personnel; Operational T&E (OT&E) personnel; Live Fire T&E (LFT&E) personnel (if applicable); and intelligence personnel. A T&E WIPT can assist a pre-systems acquisition activity (e.g., ACTD, ATD, or joint warfighting experiment) that is likely to develop into an acquisition program.

Financial Community

The financial community includes personnel in charge of overall financial activities, budget officers who prepare and defend defense budgets, and personnel who manage the spending or execution of those budgets. Employees of the Defense Finance and Accounting Service (DFAS) also provide financial support by paying defense contractors and supplying accounting information and services. Every major headquarters and most bases and installations have financial personnel.

Financial personnel are responsible for providing warfighters with the resources they need to carry out defense missions. In the process, the financial personnel support and interact with all functional communities. The interactions with the acquisition community are particularly extensive because the DoD buys so many products and because of the complexity of some of the purchases. In addition to providing needed resources, financial personnel must comply with strict timelines for preparing budgets, timelines that are often dictated by outside organizations, such as the OMB and the U.S. Congress. Financial personnel must also ensure compliance with all relevant laws and financial regulations. Although everyone must comply with laws and regulations, the financial community is the focal point for many compliance efforts.

Sometimes the responsibilities of financial managers — such as providing resources and ensuring compliance — conflict with those of other communities. An acquisition manager may want to engage in a transaction designed to speed up an important project or integrate new technology into a weapon system. The financial manager may object because the transaction cannot be done in the time allotted, or because it may violate statute or Service regulations. Some conflicts are inevitable in an environment that demands rapid decisions about complicated topics, and the deliberations that result from a conflict often lead to better decisions. Conflicts can be minimized, and those that occur can be resolved more productively if the acquisition and financial communities understand each other's roles and responsibilities.

Security Community

The security community consists of the intelligence, counterintelligence, security, and foreign disclosure organizations, staffs, and personnel. The security community advises the other functional communities about technologies sought by adversaries, capabilities for obtaining such technologies, countermeasures for protecting the technologies, and authorizations for transferring the technology to other countries.

Planning for protecting research and technology is an increasingly important aspect of technology programs. Appendix E, Research and Technology Protection Planning, outlines the considerations for ensuring that our critical technology is not disclosed to potential adversaries.

INDUSTRY'S NEW ROLE

As the previous section indicated, many government players are involved in technology transition. But industry also plays an important role — a role that is expanding as commercial R&D grows in importance.

Investment Trends

Although commercial spending for R&D has increased substantially in recent years, Federal Government spending has remained constant. Thus, the commercial sector may create a larger share of the new technologies that will support DoD's future requirements.

This shift toward commercial R&D is illustrated by the trends in total R&D funding in the United States and the amount of funding coming from the Federal Government. As shown in Figure 1-5, in 1993 total U.S. R&D investment was $166 billion. The Federal Government's contribution to this investment was $64 billion — or 38 percent of the total.[6] By the year 2000, total R&D investment in the United States had grown to $245 billion while the Federal Government's contribution held nearly constant at $65 billion,[7] representing just over one-quarter of U.S. investment (all dollar figures are in constant 1996 dollars). Thus, the Federal Government's share of total spending dropped from 38 percent in 1993 to 26 percent in 2000. DoD accounts for almost half of the total federal funding for R&D and is the largest single federal sponsor of R&D.

Figure 1-6 suggests that these trends are not new. Over the past two decades, commercial R&D spending has increased steadily over time, while DoD investment has remained relatively constant.

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[6] National Science Foundation, *National Patterns of R&D Resources 1996—An SRS Special Report*, Division of Science Resources Studies, Directorate for Social, Behavioral, and Economical Sciences.
[7] *Ibid*.

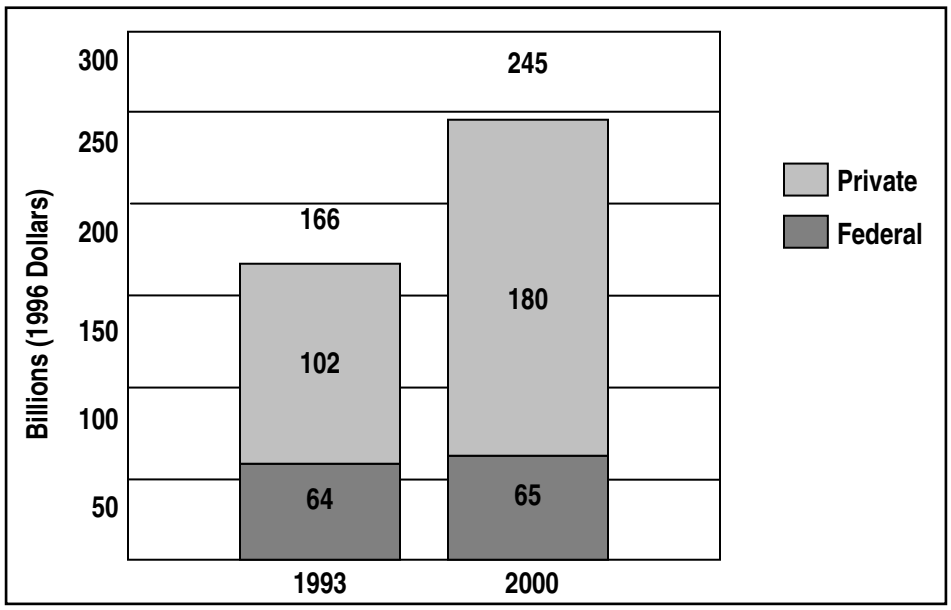

Figure 1-5. 1993 and 2000 R&D Funding

These trends suggest that DoD PMs should be more creative in integrating commercial and international technologies into defense applications. The technology can be integrated by creating partnerships between government and industry or by using DoD's direct access to industry's independent initiatives. In many cases, the technology the government needs already exists in commercial industry in some form. The government's challenge is to increase partnerships with industry to gain access to commercial technology, regardless of who provides the technology (a large or small business) and whether the supplier is first tier or lower.

Not only has DoD's share of overall R&D decreased, but its importance in certain markets has shrunk dramatically, and with it, DoD's influence on the direction of the technology. For example, DoD procures less than one percent of all semiconductors, a smaller share than the automotive industry. For this reason, unique defense requirements have little effect on the overall market, requiring DoD to use commercial technology in its military systems. Another effect of this trend is that DoD is unable to acquire Intellectual Property (IP) Rights (IPRs) for commercially developed technology, as was done for defense-funded technologies in the past, because DoD's financial involvement will be limited and its demand is not dominant compared with the worldwide commercial market. For this *Manager's Guide*, the term "intellectual property" means patents, copyrights, trademarks, and trade secrets. PMs will need to identify alternative, more commercially friendly methods of protecting IP in order to transition commercial technology to defense systems.

The guide *Intellectual Property: Navigating through Commercial Waters*[8] helps PMs identify issues and solutions for IP. During the last few years, several senior leadership policy letters have acknowledged this fundamental change in DoD's acquisition environment.[9]

[8] Available online at http://www.acq.osd.mil/dpap/Docs/intelprop.pdf.
[9] (1) USD(AT&L) Memorandum, September 5, 2000. Subject: "Training on Intellectual Property." (2) USD(AT&L) Memorandum, January 5, 2001. Subject: "Reform of Intellectual Property Rights of Contractors." (3) USD(AT&L) Memorandum, December 21, 2001. Subject: "Intellectual Property."

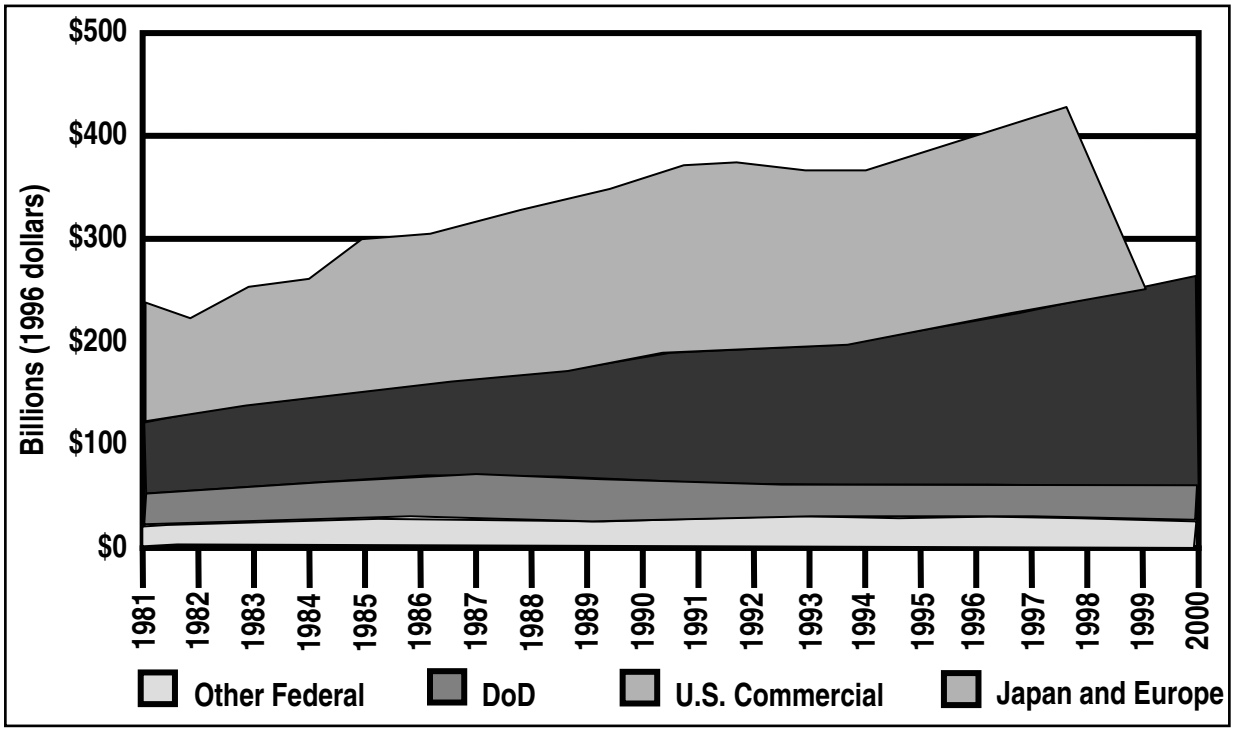

Figure 1-6. R&D Investment

The Industry Players

Industry is not a monolithic entity. It is made up of small, medium, and large companies. Some companies do business with the government routinely and others refuse to participate. We differentiate among them by breaking them into two general categories: those that traditionally do business with the DoD and those that do not. Myriad reasons exist for the reluctance by some companies to enter the defense market, including some that may have very important technologies needed by the military. Two of the major reasons cited are the need to protect IP and stringent government cost accounting requirements. PMs, as a result, must consider the contributions, limitations, and possibilities of each segment of industry when developing strategies to access technology from industry.

Table 1-1 provides summary investment, employment, and patent filing information to illustrate some differences between small and large business participation in R&D.

LARGE BUSINESS[10]

Traditional Defense Contractors (TDCs)

TDCs support DoD throughout the life cycle of systems, beginning with basic research and extending to production, sustainment, and disposal. TDCs may undertake high-dollar-valued fully funded R&D contracts, some of which are large, for which their corporate investment is often very little. The number of patents issued to defense firms is very low compared to non-defense firms, yet defense firms fund approximately $2.8 billion in IR&D, often spent on technologies they want to protect.

[10] Usually defined as firms with more than 500 employees. Normally divided into a number of separate business units and research facilities.

Business Segment	Small Business	Large Business
Dollars invested in industrial R&D, 2000	$33 billion	$148 billion
Percent of industrial R&D $	18 percent	82 percent
Employment, 1999	55,729,092	54,976,569
Percent employment	50.34 percent	49.66 percent
No. of industrial patent filings in 1999	34,020	52,102
Percent of industrial patents filed	39.5 percent	60.50 percent

Table 1-1. Business Participants in DoD Technology Development

DoD has established relationships with larger defense prime contractors for systems contracts, relying on their ability to integrate and manage systems to develop, deliver, and maintain major weapons systems. These contractors increasingly are responsible for maintaining open systems architectures, in which alternative technology solutions offered by the subcontractor supply base are introduced. Understanding the defense business, TDCs have adapted to its peculiarities and culture over time.

To encourage favorable partnerships between large TDCs and non-traditional small and large businesses, and to encourage prime contractors to implement the best available technology solutions, the government often requests, during source selection, that potential prime contractors submit a subcontracting plan as part of their proposals. The subcontracting plan should describe how the prime contractor plans to manage the supply chain to create and maintain competitive alternatives so the government can get the best technological solution for its military needs.

Non-Traditional Defense Contractors

Non-traditional, large defense contractors also play a key role. Eighty-two percent of commercial R&D investment and 60.5 percent of the patent filings come from non-traditional large firms. Accessing this part of the marketplace for commercial technology is increasingly important.

Non-traditional large firms also achieve more patents per firm. A 1998 analysis compared the top six defense firms with the top six Integrated Dual-use Commercial Companies (IDCCs). The study revealed that for every patent issued to a defense firm, six were issued to an IDCC firm. This comparison illustrates that DoD's direct funding of R&D makes defense firms different from non-traditional firms.

The companies responsible for the worldwide technology revolution in recent years typically are non-traditional large firms that do little or no business with DoD. The investments made by non-traditional firms are important to DoD, and learning to attract them to the defense market is a difficult task. Studies indicate that non-traditional firms are reluctant to enter the defense market, primarily because of IP issues and long product development times associated with weapons systems.[11]

[11] "Conducting Collaborative Research with Nontraditional Suppliers." Dr. Kenneth Horn, et al. November-December 1997, *Army RD&A Magazine*, p. 40.

Leading-edge commercial firms assure their continued existence and growth primarily by selling developed products and services in the highly competitive commercial market. Virtually every technology-rich commercial business aggressively protects its proprietary data. Normally, only a relatively few trusted business and technical employees, with a vested interest in the commercial success of the development, will have access to the data until production begins.

Non-traditional firms generally will not enter into an agreement or share their technology with DoD if they risk losing control of their IP. Agreements that give the government the rights to use the firm's technology, or that could require compulsory licensing of the firm's technology to another entity (even if the probability of such licensing is low) can prevent a firm from entering into an agreement with the government. Because of industry's vital need to protect its proprietary data, DoD may need to use "Other Transaction (OT)"[12] authority to jointly develop technology. The authority for OTs gives the government the flexibility for negotiating a balance that suits both parties and helps alleviate the concerns of commercial firms. PMs should consider using this type of contract vehicle. Even if they do not use OT authority, they must avoid including clauses in agreements that place unnecessary controls on a commercial firm's technology.

SMALL BUSINESS[13]

Like its Large Business counterpart, the Small Business sector can be grouped into Traditional and Non-Traditional Firms as well.

Small business invested $33 billion[14] in R&D in FY00 (see Table 1-1). Small businesses and independent inventors, who filed for 39.5 percent of the U.S. patents in 1999,[15] are vital to the economy. They typically work as subcontractors and lower-tier suppliers to defense contractors. They can work as prime contractors in certain situations, especially where their products are provided as Government-Furnished Equipment (GFE) to prime integrating contractors.

Small businesses can assist in transitioning technology into weapons systems. They are able to adapt to changing requirements and rapidly deploy new technologies. Traditional small businesses accommodate the defense culture and business environment more readily than do non-traditional small businesses that might not consider working for DoD.

The government may want to contract directly with a small business or obtain its support through a subcontract. The government can also encourage the traditional defense contractors to use small businesses to access technologies by putting incentives in the prime contracts, such as an award fee, for using small businesses.

Traditional Defense Contractors

The defense small business community is large and plays a key role in defense acquisition programs through the myriad programs established to access and develop small business capabilities. One of the ways of reaching this community is through the SBIR program that funds technology programs. PMs should consider the potential associated with SBIR programs and

[12] A description of the Other Transaction authority is provided in Chapter 2.
[13] Usually defined as firms with fewer than 500 employees.
[14] Data compiled from National Science Foundation Table 1, Table 1B National expenditures for R&D, from funding sectors to performing sectors: 1993-2000.
[15] Data collected by integrated dual-use commercial companies consortia from a Patents and Trademark Office report for 1999 patents filed.

urge their prime contractors to do the same. Primes need to treat small defense firms as an important source for accessing technology and nurture their innovative capability.

Non-Traditional Defense Contractors

Reasons for accessing non-traditional, small firms are very much the same as those for large non-traditional firms. Because small companies are flexible, they often can respond to market opportunities and technology breakthroughs faster than larger, more established organizations.

PMs should pay attention to the ability and interest of their traditional defense contractors in accessing technology from non-traditional sources. As with their large counterparts, non-traditional small firms will be unwilling and often unable, to comply with the myriad government-unique requirements for cost accounting, auditing, oversight, and use of IP.

2

TECHNOLOGY TRANSITION PLANNING AND TOOLS

Technology transitions can occur within the government, and between government and industry. This chapter discusses the background and some of the issues associated with each of the two types of transitions. This chapter also addresses tools that are helpful in achieving successful technology transitions. Finally, this chapter identifies key challenges and suggests ways to overcome them.

PLANNING AND TOOLS FOR GOVERNMENT-TO-GOVERNMENT TRANSITIONS

Government-to-government technology transitions can occur, for example, when a government lab provides a technology to an acquisition program for application in a new weapons system. Those dealing with government-to-government transitions need to understand the environment in which transitions take place and the regulations that govern them.

Environment and Challenges

Technology transition often starts with the S&T process. This process is a pre-acquisition activity that focuses on gaining knowledge about technologies that apply to the military. The S&T community is challenged to maintain a broad-based program that addresses all sciences relevant to the nation's defense, with an emphasis on future needs and technologies that are not being investigated by industry. The S&T community oversees the developing technologies until they are mature enough to be integrated into new systems. The Acquisition and R&D communities then collaborate on the maturation of a technology until it is fully incorporated into a specific system.

The transition of oversight between the three communities does not occur at a fixed point in the development process. How and when the transition occurs depends on many factors. The transition between the S&T, R&D, and acquisition communities is one of the critical phases in developing a product. To ensure the transition is successful, the communities must communicate, their responsibilities must be clearly delineated, and funding must not be interrupted.

DoD's budgetary arrangements usually require that transitions be predicted 18 to 24 months in advance. DoD's Research, Development, Test, and Evaluation (RDT&E) budget account is divided into seven Budget Activities (BAs), each with its own numerical designation, as shown in Table 2-1.

Typically, RDT&E funding, which is available for obligation for two years after it is appropriated, is used for all efforts under this budget activity.

Community	Numerical Designation	Category
RDT&E Science and Technology	BA 1	Basic Research
	BA 2	Applied Research
	BA 3	Advanced Technology Development
RDT&E Acquisition	BA 4	Advanced Technology Development and Prototypes
	BA 5	System Development and Demonstration
	BA 6	RDT&E Management Support
	BA 7	Operational Systems Development

Source: DoD 7000.14-R *Financial Management Regulation (FMR)*, June 2002.

Table 2-1. DoD RDT&E Budget Activities

Budget Activities 1, 2, and 3 comprise traditional S&T efforts; BAs 4 and 5 fund R&D efforts; and with some overlap, BAs 4 and 7 usually fund acquisition efforts. Traditionally, technology moves through these budget categories linearly, with a management shift from S&T to R&D and acquisition at BA point. To make a seamless transition, the S&T, R&D, and acquisition communities must communicate early and often. For example, the communities must discuss planned upgrades to existing acquisition programs to ensure that the S&T community's BA 3 programs meet the phasing of the acquisition community's upgrades. The Integrated Product and Process Development (IPPD) process outlined in this chapter can assist with the communication challenges and help to ensure a smooth transition.

Operating under this budgetary arrangement, the S&T, R&D, and acquisition communities face a number of challenges associated with technology transition. The primary ones follow:

- **Contracting Strategy** — motivating the contractors to provide a best-value solution (in terms of overall Life Cycle Cost (LCC) effectiveness) and transition into procurement without losing momentum.

- **Interoperability** — ensuring that the technology can interface with other systems on the battlefield.

- **Supportability** — ensuring the fielded systems are maintained at a high state of readiness and safety, using trained operators and maintainers who do so economically and with the smallest possible logistical footprint.

- **Test and Evaluation** — integrating testing and evaluation of both development and operations swiftly and economically to ensure that requirements are met and the system is operationally satisfactory and useful.

- **Affordability** — setting goals for acquisition and LCCs that permit CAIV trade-offs of requirements, then later Design-To-Cost (DTC) trade-offs within a fixed set of requirements. Sustainment issues must be addressed as early as possible, to reduce the Total Ownership Cost (TOC) associated with a system.

- **Funding** — choosing the proper strategy for obtaining the resources necessary for acquiring the technology.

- **Capability Needs** — evolving from the initial capability need and performance goals to a formal capability development document/system performance specification, then to applying the technology.

DoD's 5000 Series Documents
As the discussion of the environment suggests, technology transition involves several key players and must confront a number of challenges. The DoD 5000 Series provides the framework for addressing and overcoming the challenges.

As DoD's basic acquisition policy documents, the DoD 5000 Series is the basis for meeting technology challenges and creating a future when advanced technology can be delivered to our warfighters faster; at lower TOCs; using interoperable, affordable, and supportable systems. The DoD 5000 Series documents[1] describe mandatory procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) acquisition programs and are a model for other defense acquisition programs.

The following section is an overview of the May 2003 5000 Series. Top-level changes were discussed in Chapter 1.

Objectives of the 5000 Series
As introduced in Chapter 1, the May 2003 5000 Series policy incorporates five primary policy objectives for acquiring new systems: (1) Flexibility, (2) Responsiveness, (3) Innovation, (4) Discipline, and (5) Streamlined and Effective Management.

The first objective of the new 5000 Series, *Flexibility*, explicitly recognizes that there is no one best way to structure a defense acquisition program. PMs and decision authorities are required to tailor their programs to the particular set of circumstance their programs face. They are further encouraged, within the limits of applicable law and regulation, to weed out non-value added requirements and documentation and to custom fit the timing and scope of decision reviews.

To meet the second objective, *Responsiveness* — getting advanced technology into the hands of the warfighters as quickly and efficiently as possible — the cycle time for developing new systems needs to be reduced. That means moving to time-phased capability needs documents and evolutionary acquisition while relying on commercial technology whenever possible. Using time-phased capability needs involves developing systems based on a shorter time horizon to meet foreseeable threats while developing better information about future threats. Evolutionary acquisition involves using current and proven technologies while refining tomorrow's technologies for tomorrow's systems. The combination of time-phased capability needs and Spiral Development (SD) gives the warfighters increasingly better capability and the most advanced technology. It also allows these systems to be upgraded as the technology evolves.

To reduce the time needed for developing new systems, the May 2003 5000 Series documents introduced an acquisition model that extends from S&T phases, through system acquisition, all

[1] DoDD 5000.1, DoDI 5000.2, and the *Defense Acquisition Guidebook* can be accessed through the Defense Acquisition Resource Center at http://akss.dau.mil/darc/darc.html.

the way through operation and support to demilitizarization and disposal. The current model has three distinct activities:

- Pre-systems Acquisition, which includes developing mission needs and technology opportunities, as well as concepts for developing technology;

- Systems Acquisition, which includes developing, demonstrating, producing, and deploying the system; and

- Sustainment, which includes operation and disposal.

To meet the third objective of the DoD 5000 Series policy, *Innovation*, PMs need to understand the value of a required capability to the warfighter. In other words, how much is the warfighter willing to invest in a particular system for both acquisition and support? PMs also need to have an acquisition and logistics strategy that maintains the pressure to hold down costs throughout the life cycle. Warfighters can help PMs when, as recommended by the DoD 5000 Series instructions, they define their capability needs up front in terms of a limited number of performance parameters as well as an affordability goal, giving the PM and industry partners adequate trade space[2] to develop affordable solutions. Another way to maintain affordability throughout the life cycle is to have competition, if not for the prime contract, then at lower levels of the supply chain where the bulk of the cost for complex weapons systems is normally incurred. By ensuring head-to-head competition or by exploring alternative solutions to mission needs, PMs and prime contractors can keep new systems affordable.

The fourth objective, *Discipline*, requires that PMs establish a minimum set of cost, schedule, and performance goals that are used to track program performance over its life. A program baseline is established at program initiation and deviations from that baseline are identified and corrective action is taken as appropriate.

Finally, to meet the fifth DoD 5000 Series objective, *Streamlined and Effective Management*, acquisition authority is to be decentralized "to the maximum extent practicable." A single individual, the PM, is to be invested with sufficient authority to execute program objectives for development, production, and sustainment of the system.

DEFENSE ACQUISITION MANAGEMENT FRAMEWORK

The Defense Acquisition Management Framework consists of three primary activities — Pre-Systems Acquisition, Systems Acquisition, and Sustainment — divided into 5 phases: Concept Refinement (CR), Technology Development (TD), System Development and Demonstration (SDD), Production and Deployment (P&D), and Operations and Support (O&S). The Framework is flexible with tailorable entry and exit points. The process begins when a capability need requiring a material solution is matched with an available, mature, affordable technology. Entry into the Framework can occur at a number of different points and is dependent upon a number of

[2] "Trade space" is a term used in the CAIV process. Capability Needs are divided into two categories: those capability needs that are designated as non-negotiable "Key Performance Parameters," (KPPs) and those which are not designated as KPPs. The KPPs must be delivered at threshold levels. The others can be "traded off" (causing reductions in performance and capability in non-critical areas) to meet affordability goals. The PM's ability to reduce program costs by reducing non-KPPs is the PM's "trade space."

different factors including the maturity of the operational need, the maturity of the enabling technology, and availability of funding.

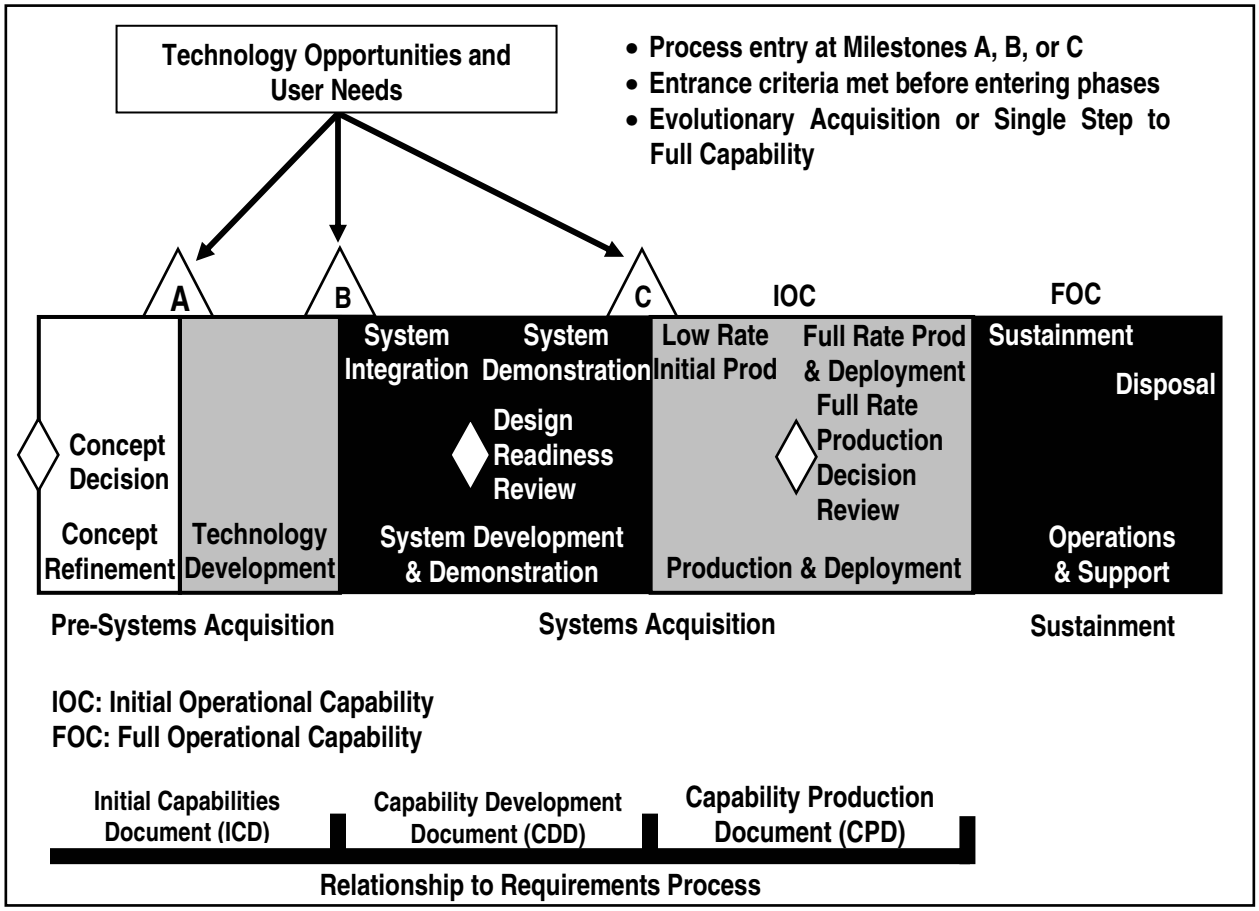

Figure 2-1. Defense Acquisition Management Framework

Pre-Systems Acquisition Activity

The Pre-Systems Acquisition Activity is composed of activities primarily related to technology development work and those activities leading to the refinement of the material solution identified in the approved Initial Capabilities Document (ICD). Pre-systems acquisition consists of two phases, CR and TD.

The CR phase begins with a Concept Decision by the Milestone Decision Authority (MDA) and ends with a successful Milestone A decision that allows the program to transition into the next phase. The primary focus of CR is as its title suggests, refining the initial concept. Additionally, the Technology Development Strategy (TDS) is drafted and a plan for the conduct of the Analysis of Alternatives (AoA) is crafted. The emphasis in this phase is on innovation and competition and on drawing from existing solutions from a wide range of sources.

The TD phase begins after a successful Milestone A decision. The primary focus of this phase is to reduce technology risk and determine the appropriate set of technologies to integrate into a full system. A number of technology demonstrations are usually conducted to illuminate the most mature and affordable technologies that will in turn support the most operationally useful

solution. TD concludes when the technology for an affordable increment of militarily useful capability has been demonstrated in a relevant environment.

Systems Acquisition Activity
The Systems Acquisition Activity consists of the SDD and P&D phases. In this activity enabling technologies are integrated and the system is fully developed, tested, produced, and deployed to the operational user.

The SDD phase begins with a successful Milestone B, which is the decision point at which formal program initiation usually occurs. SDD has two major efforts: System Integration (SI) and System Demonstration (SD). The purpose of SDD is to develop the system, reduce risk, and ensure operational supportability. A management decision review called the "Design Readiness Review" (DRR) is held at the completion of SI to determine the readiness of the system to proceed to SD. The SD effort and the SDD phase are normally complete when the system has been demonstrated in its intended environment and has proven its capability to meet or exceed the threshold values of its Key Performance Parameters (KPPs).

The P&D phase begins with a successful Milestone C decision and launches the system into the first effort, Low Rate Initial Production (LRIP), of the two efforts that comprise this phase. The second effort is the Full Rate Production and Deployment (FRP&D) effort. The primary goal of this phase is to achieve an operational capability that satisfies the operational need of the warfighter or end user. The Full Rate Production Decision Review (FRPDR) separates the two efforts of this phase. LRIP results in the assurance of adequate manufacturing capability, establishes an initial production base, provides production articles for operational testing, and begins an orderly ramp-up to full rate production. During FRP&D the system is produced in quantity and deployed to the warfighter or end user. Some follow-on testing might occur during this phase to ensure that deficiencies identified earlier have been corrected.

Sustainment Activity
The Sustainment Activity is comprised of the O&S phase, which is further subdivided into the Sustainment and Disposal Efforts.

The O&S phase witnesses the achievement of Full Operational Capability (FOC) and the assessment of operational readiness. Operational readiness is continually monitored to ensure that the system meets the needs of the warfighter/end user. The Sustainment effort consists of all the myriad activities that occur to keep an operational system up and running in the field. During Sustainment, system modifications are made to improve system performance and reduce operating cost. If the modifications are of sufficient scope, complexity and cost, they might be managed as a separate defense acquisition program. Disposal of the system occurs at the end of its militarily useful life and is in accordance with the system's disposal plan. The disposal plan was developed during the SDD phase and ensures that DoD complies with all necessary Environmental, Safety, and Health (ESH) concerns.

The framework separates TD from SI, and production comes after the capabilities of the technology are demonstrated. Ultimately, the acquisition framework enables PMs to reduce cycle time by concentrating on proven technology and producible systems. All of these features of the acquisition process are part of the criteria that must be met before entering each phase. As stated

earlier, depending on the maturity of the technology and the user need, a system can enter the acquisition framework at different places in the development continuum.[3]

PLANNING AND TOOLS FOR INDUSTRY-TO-GOVERNMENT TRANSITIONS

In the past, DoD developed technology that it needed without much emphasis on how the technology affected, or was affected by, the commercial sector. Defense technology was ahead of commercial technology in many of the critical areas needed by the department. Now, industry's technology is the leader in many areas. DoD must seek the state-of-the-art technologies being developed by industry and use the advantages of industry's market-driven and cost-constrained products.

In many ways, transitioning technology from industry to government involves the same issues and problems as government-to-government transitions. Therefore, the guidance and suggestions in the preceding section generally apply.

There are, however, special issues involved in transitioning technology from industry to government. Industry partners want reasonable compensation for their technologies and appropriate safeguards on their Intellectual Property (IP). Furthermore, companies that do not traditionally deal with DoD often shy away from government contracts because of unusual cost or auditing requirements. Non-traditional defense companies can be a source of innovation and technology, but they may not have the resources to develop their technology independently to the degree needed for a particular program.

New tools exist to address the challenges of broadening the technology resources available to DoD by promoting industry-to-government technology transitions. Arrangements that would have been radical or impossible in the past are becoming routine. Under certain conditions, the government and industry can share resources while technology is being developed, and companies can use the results for their benefit. A number of tools are available, and more will become available as acquisition initiatives continue to be put in place.

Acquisition initiatives already have modified policies for collaboration, sharing costs, and offering incentives when working with industry partners. For example, contractual options exist that allow companies to retain some or all of their IP rights — a necessary precondition when DoD wants to use technology that can also be sold in large commercial markets. Other changes include a departure from restrictive military standard specifications, a more flexible menu of contracting options, the option of integrating military and commercial development and production, and a program for developing dual-use technologies.

Options also exist that will allow DoD to pool government and industry resources to tackle commercial technology programs of interest to DoD that are too large for industry alone. Incentives are available for increasing the profit margins of industry partners when they accept risk in program development. Use of these options and incentives requires detailed planning and coordination.[4]

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[3] For a more detailed discussion of the Defense Acquisition Management Framework and all of its piece parts, see *DAU's Introduction to Defense Acquisition Management*, available at http://www.dau.mil/pubs/gdbks/idam.asp.

[4] A detailed discussion of this topic is in "Department of Defense (DoD) and Industry — A Healthy Alliance," master's thesis by Vicki L. John, Naval Postgraduate School, Monterey, CA 93943-5000.

As lessons continue to be learned, the acquisition process will improve these tools and create new, more flexible ways to deal with industry. However, in most cases, the basic tools are in place, although to use them may require the agency to depart from its normal business and contracting processes. In some cases, the agency may resist such changes, but organizations that are familiar with the tools normally can find a way to operate that will bring industry into their programs while protecting the government. The ability to partner with industry and use its advantages in technology is critical for today's PMs and technology providers.

Understanding industry's perspective on technology transition opportunities is important. In industry, the business case analysis underlying an opportunity is usually the most important element considered. A Return on Investment (ROI) of 10:1 or higher is usually needed to proceed. If the ROI is less, the industry manager may not be allowed to proceed with the opportunity. Cost sharing and IP rights will be considered. If a company has a "world-class" technology, they will hold the IP rights closely. If the government wants industry to share the costs or the IP rights, the government may not have access to some of the best technologies. Understanding industry's viewpoint on specific programs also is important.

For some technology development, industry will accept losing some exclusivity of its IP if the government shares some of the up-front costs. If the company can share costs and keep the IP, it may view the opportunity very favorably. Government technologists must understand industry's perspective about specific opportunities. They must then strike the balance that brings technology to the field, while protecting the government's interests.

Business Arrangements

Business arrangements are important considerations in planning industry-to-government technology transitions. The legislation authorizing an S&T program may include information about the specific business arrangement that must be used. Otherwise, an agency has the discretion to select from several business arrangements that are available for obtaining necessary S&T support. The legal instruments for S&T support are contracts, grants, cooperative agreements, OTs, and Technology Investment Agreements (TIAs). Table 2-2 highlights some distinctions among these S&T business arrangements.

As Table 2-2 illustrates, procurement contracts and OTs are used when the government's principal purpose is acquiring goods or services for its direct benefit. *Acquisition* is the act of acquiring goods or services that the government will use or that directly benefit the government, i.e., buying something that the government needs.[5] R&D, including S&T for meeting military needs, can be considered either goods or services, depending on the deliverable. Grants, cooperative agreements, and TIAs are assistance instruments. *Assistance* is used to support or stimulate activities for improving the public good.[6] Cooperative R&D Agreements (CRADAs) are agreements that are not assistance instruments.

[5] *Federal Grant and Cooperative Agreement Act of 1997*, P.L. 95-224. Subsequently recodified as Chapter 63 of P.L. 97-258 (Title 31 U.S.C. 6301 et seq.).
[6] *Ibid*.

	Contract	Grant/ Cooperative Agreement	Cooperative R&D Agreement (CRADA)	Other Transactions for Prototype Projects	Technology Investment Agreement
Principal Purpose	Acquisition	Assistance	R&D	Acquisition	Assistance
Funding	Full or partial funding	Full or partial funding	Shared between partners	Full or partial funding	Full or partial funding
Publicity	FedBizOps	FedBizOps	Varies	FedBizOps	FedBizOps
Involvement level of government	Oversight only	Substantial for cooperative agreements	Partnership with CRADA partner	Substantial oversight and partnering with industry	Substantial oversight and partnering with industry
Typical S&T Product	Deliverable end product	Research reports or training	Varies	Deliverable	Research projects
Typical Recipient	Traditional for-profit government contractor	Educational or non-profit institution	Industry, other government agencies, universities	Traditional government contractor with significant involvement non-traditional for-profit commercial company	Traditional government contractor with significant involvement non-traditional for-profit commercial company
Solicitation Methods	Request for proposal, broad agency announcement, unsolicited proposal	Broad agency announcement, research announcement, unsolicited proposal	Selection by agency	Broad agency announcement, research announcement, program solicitation, unsolicited proposal	Broad agency announcement, research announcement, unsolicited proposal

Table 2-2. Distinctions Among S&T Business Arrangements

Procurement Contracts

The government generally satisfies its acquisition requirements through a procurement contract. The framework for federal procurement contracts is provided by the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS). These regulations define a system whose objective is to acquire high-quality products on time and at reasonable cost. With some exceptions, the system relies on full and open competition, making the opportunity available to all responsible contractors.

Contracting begins with an agency researching the market and developing an acquisition plan. The program office, building on the warfighter's capability needs document, crafts a Statement of Work (SOW) or Statement of Objectives (SOO) and evaluation criteria to be used for selecting the winning contractor. Offers are solicited and an award is made. The award is a formal contract that defines the rights and responsibilities of the contracting parties, and describes the deliverables, schedule, and forms of payment. In general, R&D contracts are executed using the procedures of FAR Part 15, *Contracting by Negotiation*.

Based on the Federal Acquisition Streamlining Act (FASA), FAR Part 12, *Acquisition of Commercial Items*, was created to promote the purchasing of commercial items and to enhance

the opportunities for attracting commercial industry to the government marketplace. Using the streamlined procedures of FAR Part 12 to acquire commercial services — including research-related services — furthers those objectives. In addition, recent legislative language gives incentives for using FAR Part 12 when buying performance-based services. FAR Part 12 permits DoD to procure commercially available goods and services using terms and conditions appropriate to the private sector, and based on market prices instead of requiring detailed cost-based estimates. The prime contractor, when acquiring commercial items for use in a military system, should extend Part 12 to subcontractors. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L) August 24, 2001, memorandum about contracting for applied research states, "Although applied research…is generally suited to the use of cost-reimbursement types of contracts, some research requirements are suitable for acquisition with fixed-price types of contracts…provided they can be defined with a degree of clarity sufficient to enable offerors to price the effort needed to achieve the required results without assuming undue risk. However, because they are specific in nature, applied research efforts do not fall within the definition of a commercial item." The memo suggests that for research-related services (e.g., testing or lab services that may have a commercial market), the acquisition team should investigate using FAR Part 12. Under FAR Part 12, a fixed-price contract is required. For a research-related services contract, the structure would need to permit milestone-type achievements and payments, without exposing the contractor to undue risk.

Grants and Cooperative Agreements

As defined in the Federal Grant and Cooperative Agreement Act,[7] a grant or a cooperative agreement is a legal instrument used by a federal agency to enter into a relationship whose principal purpose is assistance (that is, the transfer of something of value to the recipient for carrying out support or stimulation authorized by U.S. law). This is in contrast to procurement contracts used to acquire goods and services for the U.S. Government's direct benefit or use. For obtaining assistance, agencies must use grants if the involvement between the recipient and the government will not be substantial; agencies must use cooperative agreements if the involvement will be substantial. Cooperative agreements are a form of financial assistance to be used when the government wants to participate in the program with the recipient. Traditionally, grants and cooperative agreements have been executed with academia and other non-profit organizations for basic research. Under these arrangements, the recipients share their results by publishing their research findings in public forums.

OMB Circulars A-110, *Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations*,[8] and A-102, *Grants and Cooperative Agreements with State and Local Governments*,[9] contain guidance about issuing grants and cooperative agreements. For DoD, the controlling regulation is the DoD Grants and Agreement Regulation (DoDGAR).[10]

Cooperative Research and Development Agreements (CRADAs)

A CRADA is a way to conduct specific R&D activities, consistent with a DoD agency's mission, with non-federal partners such as industry and universities. A CRADA is not considered a procurement contract, grant, or cooperative agreement. The document for a CRADA, which

[7] Title 31 U.S.C. 6304 and 6305.
[8] Available online at http://www.whitehouse.gov/omb/circulars/a110/a110.html.
[9] Available online at http://www.whitehouse.gov/omb/circulars/a102/a102.html.
[10] 32 CFR Part 21, 22, 25, 32, and 34.

should be drafted with the assistance of legal counsel, is an "agreement" and not a contracting instrument, although it does contain components of a "contract" since items are provided for consideration.

A CRADA[11] is a written agreement between one or more DoD laboratories or technical activities and one or more non-federal parties such as state and local governments; commercial industry; public and private foundations; and non-profit organizations. The parties to a CRADA may exchange IP, expertise, and data. They may also exchange the use of personnel, services, materials, equipment, and facilities. DoD agencies can accept funding from a CRADA partner to perform research or development of benefit to the partner, but no DoD funds can flow to the CRADA partner.

The DoD activities can provide personnel, facilities, equipment or other resources, with or without reimbursement. The non-federal partners can provide funds, people, services, facilities, equipment, or other resources.

The rights to inventions and other IP are flexible and are negotiated as a part of the agreement with industry.

Other Transactions (OTs) for Prototype Projects

"Other Transactions" (OTs) is the term commonly used to refer to the 10 U.S.C. 2371 authority to enter into transactions other than contracts, grants, or cooperative agreements. This basic authority is permanent and has been incorporated by DoD into Technology Investment Agreements (TIA). TIAs are considered assistance agreements.

DoD has another procurement authority, which is temporarily called "Other Transactions for Prototype Projects" or simply "OT." This type of OT is authorized by DoD authorization acts with sunset provisions and is in the U.S. Code as a note in 10 U.S.C. 2371. Section 845 of P.L. 103-160, as amended, which authorizes using OTs, under the authority of 10 U.S.C. 2371, for prototype projects directly relevant to weapons or weapons systems anticipated to be acquired or developed by DoD. This OT is commonly referred to as an OT for a prototype project, or a "Section 845 OT."[12]

In general, OTs for prototype projects are not subject to the federal laws and regulations governing procurement contracts. For this reason, they do not have to comply with the FAR, its supplements, or laws that apply to procurement contracts. For example, OTs for prototype projects allow for flexibility in accounting practices and auditing procedures, and can result in IP provisions that differ from those usually in regular procurement contracts.

This acquisition authority, when used correctly, is a vital tool for helping DoD integrate the civil and military technologies and management processes that are critical for reducing the cost of defense weapons systems. OT authority for prototype projects may be used when:

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[11] For more information on CRADAs, see 15 U.S.C 3710a; DoD Directive 5535.3, *DoD Domestic Technology Transfer (T2) Program*, May 21, 1999; and DoD Instruction 5535.8, *DoD Technology Transfer Program Procedures*, May 14, 1999. Additionally, the Services and DoD technical activities have guidance on CRADAs, and in most cases, model CRADAs.

[12] For further guidance, see *Other Transactions (OT) Guide for Prototype Projects*, published January 2001 by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)). The Guide is available online at http://www.acq.osd.mil/dpap/.

- at least one non-traditional defense contractor participates significantly in the prototype project; or

- no non-traditional defense contractor is participating significantly in the prototype project, but at least one of the following circumstances exists:

  - A non-government party to the transaction funds at least one-third of the total cost of the prototype project.

  - The agency senior procurement executive determines in writing that exceptional circumstances justify using a transaction that provides for innovative business arrangements or structures that would not be feasible or appropriate under a procurement contract.

Agencies are encouraged to pursue competitively awarded prototype projects that can be adequately defined to establish a fixed-price type of agreement and attract non-TDCs to participate significantly.

DoD agencies using the Section 845 OT authority must consider the risks and rewards. Does the commercial firm have a technology that DoD needs? Can DoD influence the development of the technology so the firm incorporates unique military requirements? If so, does attempting to place IP restrictions on the technology that the commercial firm is unwilling to accept make sense? In most cases, the technology will be developed and marketed anyway, but DoD will have lost the opportunity to readily access the technology or influence its development.

Advantages of OTs for Prototype Projects

Integrating the government and commercial sectors of the national technology and industrial base, including commercial companies and the commercial business units of TDCs, is in DoD's best interest. Under OTs for prototype projects, TDCs should be encouraged to integrate commercial companies into the prototype projects. That is, the contractors should seek out commercial companies or commercial business units when the commercial companies have state-of-the-art technologies and off-the-shelf products that can reduce the government's acquisition costs and solve operational challenges. Using commercial practices to solicit and award commercial contracts can attract non-traditional contractors to do business with DoD.

Streamlined commercial subcontracting is one advantage of an OT for prototype projects. Section 845 OTs differ from FAR/DFARS-based contracts, which specify mandatory prime and subcontract requirements, government oversight, and demands for access to IP. OT subcontracts can be constructed to reflect a commercial business arrangement or can use the terms and conditions of FAR Part 12. Sometimes the prime contractor for a Section 845 OT is actually one company selected to represent a consortium of companies that bids on the project. The prime contractor may be selected for its expertise in dealing with the government, whereas the management of the consortium may operate more as a joint venture, with most or all participants actively involved, including the government PM. In some Section 845 OTs, companies may still be simply suppliers (normally for incidental aspects of the OT), rather than members of the consortium. PMs must observe subcontracts between the prime company and the others, and the normal privity of contracts, so as not to undermine the management of the OT (even if by a consortium of companies).

The authority for OTs for prototype projects allows the parties to create new supply chain relationships, which include managing the suppliers rather than the supplies. Managing the suppliers is a "best commercial practice" noted by the General Accounting Office (GAO) in its report *Best Practices: DoD Can Help Suppliers Contribute More to Weapons System Programs*.[13] This type of management means having a strategic sense to pick the most capable suppliers (i.e., judged on past performance), providing them the right incentives to perform well, and then monitoring the supply chain to observe emerging issues with technology, labor, finances, sources, etc., that may indicate weaknesses that could affect performance. In addition, this type of management means establishing long-term strategic relationships with suppliers instead of holding annual competitions and finding other means to stimulate suppliers to be innovative and reduce costs. Often these incentives include adding years of work to the contract or offering the option of producing the subsystem or component of the prototype, if it goes into production.

The ability to establish long-term strategic relationships with key suppliers is another advantage of this authority. Both the GAO report and a 2000 RAND report, *Commercial Approaches to Weapons Acquisition*, point out the problem of the FAR contract system, which requires actions that create contractual provisions that are inconsistent with the goal of establishing long-term commercial relationships. The authority under an OT for prototype projects can be used to deal directly with strategic alliances, to require no flow-down provisions to lower-tier subcontractors, and to establish trust relationships in the contractual vehicles. By using commercial practices to solicit and award commercial contracts, DoD can attract non-traditional contractors.

The ability to use payment methods that focus on technical accomplishments represents another important advantage of OTs for prototype projects. By using the OT flexibility, DoD can use Performance-Based Payments (PBPs) as the preferred financing approach. The ability to recover funds from the contractor and reuse them for other programs may represent yet another advantage of OTs for prototype projects.

Section 845 OTs also allow defense contractors to use their IR&D funds, or commercial businesses to use the funds that were set aside for commercial investments in new technology, to expand the technology alternatives or concepts in early phases of a program. This sharing of the costs to investigate new technologies, mature existing or developing technologies, or test new technologies in a military environment, is a funds multiplier that may represent one of the biggest advantages associated with Section 845 OTs. Under FAR-based contracts, contractors are prohibited from doing any part of a project using IR&D funds.[14] In contrast, OTs permit the joint performance of the work using both government-provided assistance funding and the company's IR&D or other R&D funds.[15] By DoD policy, federal funds received for work done under OTs for prototype projects are credited to the IR&D pool.[16] These federal funds become an extension (or credit) to the funds in the IR&D pool, which the contractor uses to fund its undertakings. For example, a contractor might allocate $100,000 to do a particular IR&D project. The contractor combines this project with an OT for prototype projects and spends $200,000 in the IR&D pool. The government funds are paid under the OT for prototype projects and are

[13] Chapter Report, GAO/NSIAD-98-87, March 17, 1998.
[14] FAR Part 31-205.18(a).
[15] FAR Part 31-205.18(e).
[16] OUSD(AT&L), *Other Transactions (OT) Guide for Prototype Projects*, January 2001.

credited to the IR&D pool. The result is $200,000 of work charged at the IR&D rates, but only $100,000 to the IR&D pool.

The ability to stimulate contractor investment in Section 845 OTs has restrictions. As specified by the USD(AT&L) in a memorandum dated May 16, 2001, DoD should not attempt to require contractors to share costs in DoD R&D if the goal is strictly military. Contractors should be encouraged to invest only if the opportunity for commercial development exists as well. Agencies are encouraged to pursue competitively awarded prototype projects that can be defined adequately enough to establish a fixed-price type of agreement and attract non-TDCs to participate significantly.

Acquisition planning and expected follow-on activities are essential ingredients of a successful prototype project. Prototype projects should use a team approach. Early and continued communication among all parties — including program management, logistics, test and evaluation, and legal counsel — will enhance the opportunity for a successful project.

The OT authority and Section 845 OT authority have been used in more than 300 programs. They have also been used in every Service, as well as in DARPA and the National Geospatial-Intelligence Agency (NGA). A number of OT success stories are provided in Appendix C.

Technology Investment Agreements (TIAs)

TIAs can be used to carry out basic, applied, or advanced research projects when it is appropriate to use assistance instruments and the research is to be performed at least in part by for-profit firms, especially as members of consortia. TIAs allow DoD Components to leverage for defense purposes financial investments made by for-profit firms in research related to commercial products and processes.

The basic idea behind a TIA is flexibility. TIAs enable DoD to contract with firms that will not, or cannot, participate in government cost-reimbursement R&D FAR contracts or standard federal assistance awards. These firms might be small, start-up technology firms supported by venture capital, leading-edge technology firms that have never worked on a government R&D contract, or industry giants that have chosen not to operate in the government market. The key advantages of TIAs are as follows:

- Many of the regulatory controls of a procurement contract, grant, or cooperative agreement do not apply to a commercial firm under a TIA. The non-applicable controls include government audit, government cost principles, compliance with the Cost Accounting Standards (CASs), compliance with the Truth in Negotiations Act (TINA),[17] and subcontracting requirements;

- Commercial business practices are acceptable. For example, TIAs allow using periodic payments based on achieving agreed-on technical milestones rather than simply accumulating costs under government-mandated cost accounting rules;

- Greater flexibility for negotiating appropriate terms and conditions. Patent rights for inventions and ownership of the data generated are subject to negotiation, as are the Government-Purpose License Rights (GPLR) clause and "march-in rights." The

[17] P.L. 87-653.

government can negotiate all license rights for technical data and computer software, regardless of existing regulations;

- Technical insight is gained, enhancing visibility into research at every level; and
- The leveraging of government resources reduces the risk.

Because these advantages come without the fixed contractual terms of the normal regulated FAR contract, the government PM's responsibilities are increased under a TIA. However, there are also advantages for PMs. Under the traditional contractual relationship of prime contractor–subcontractor, the PM lacks visibility into the research work at levels beneath the prime. Unlike the traditional "prime-sub" relationship of a contract, TIA team members (regardless of business size) are equal in the team organization and, more importantly, with the PM. Thus, the PM has visibility into research at all levels. This greatly increases the effects of the PM's advice and guidance during the program. Because the team is sharing investment and project risk, the PM must recognize the needs and desires of all team members. Being able to recover funds from a recipient and reuse the funds for programs may be another TIA advantage. TIAs also exempt some offerors' information from disclosure under the Freedom of Information Act (FOIA).

Unlike contracts, which focus on completing a detailed SOW, TIAs emphasize managing change and working with team members to meet the technology goals successfully. TIAs are covered in the FAR, Part 37 and will also be covered in a part of the Department of Defense Grant and Agreement Regulations (DoDGARS).

Venture Capital (VC) Programs: An Emerging Option

While not one of the official business arrangements listed above, DoD is increasingly interested in experimenting with different forms of VC funding to assist DoD in acquiring new technology. In simple terms, "VC funding" is funding for investing in immature, high-risk/high-payoff technologies, in the hopes of finding a technology that works well. Venture capitalists "add value" to the technology developer by providing contacts; shaping ideas; and helping with management, product development, marketing, commercialization, or funding. VC funding is normally, but not exclusively, focused on small companies or "start ups." The traditional motive and selection criteria for investing VC are profit. But only a small fraction of traditional VC investments pay off in a large way. Also, less than one percent of commercial start-ups receive VC funding, with 90 percent of commercial funds invested in Information Technology (IT) and health care.

DoD's motive for using VC arrangements is the acquisition of innovative technology that reflects DoD's needs. This is a way to foster entrepreneurial behavior in DoD, and to access a broadened technology base. By investing through VC arrangements, DoD can shape the technology available up front.

This is an emerging program and VC will be implemented differently in different organizations. Recent examples of VC approaches illustrate the possibilities. The FY 2002 National Defense Appropriations Act (NDAA) required the Army to establish a $25 million non-profit VC company. The Army's VC company focused on providing electrical power for Fort Benning, GA. The Congress directed the Navy to study VC, and report on their conclusions and possible implementation. NGA has a technology development contract with a private company. The

private company voluntarily contributes its award fee to a VC fund for advancing NGA technology.

TOOLS FOR TRANSITION PLANNING

The previous sections discussed approaches that transition technology from government to government and from industry to government. All of these approaches require planning to meet the myriad of challenges. Fortunately, a number of tools are available to assist the PM in this planning.

Two of the many tools that are available are the use of the IPPD method and its extensive use of Integrated Product Teams (IPTs). Also Technology Readiness Levels (TRLs) and Engineering and Manufacturing Readiness Levels (EMRLs) provide "yardsticks" for evaluating technological maturity. A TRL-like process, based on a Missile Defense Agency (MDA) initiative, provides an additional tool for assessing engineering and manufacturing readiness.

Integrated Product and Process Development (IPPD)

The IPPD method can ensure that all necessary elements, including design and manufacturing issues, sustainability, and logistics considerations are included in technology transition planning. For this method to be beneficial, the government and industry players must continually communicate with one another, beginning with the initial requirements definition. Not only must manufacturing and sustainability issues be addressed early, they must be considered as important as performance issues for allocating the resources and prioritizing the technology. Programs must remain open to better solutions, and be prepared to use technology "outside" government and industry, in order to increase capability and maintain affordability.[18]

The IPPD is a management process that integrates all activities from product conception through manufacturing and supporting the product in the field. IPPD uses multi-functional industry and government teams to simultaneously optimize both the product and its manufacturing and sustainment processes. The goal is to meet both cost and performance objectives. In the past, separate groups, operating independently, designed a product and then sent the design to a manufacturing organization. The manufacturing organization recommended changes to the design to facilitate manufacturing, requiring the design and manufacturing organizations to communicate back and forth continually. After the system was produced, issues of logistics supportability were discovered. The IPPD method is designed to address manufacturing and sustainability issues up front in the technology development process.

The centerpiece of the IPPD method is the IPTs that are mandated in acquisition policy guidance. The IPTs must be cross-functional and multi-disciplinary, but should comprise a reasonable number of members. Getting the right members is critical. The IPTs should do the following:

- Shift the priorities from just performance to integration of performance, producibility, LCC, and implementation risk;

[18] For a discussion of the IPPD method, see the DUSD (S&T), *Technology Transition for Affordability: A Guide for S&T Program Managers*. April 2001. For consistency, we adopted the IPPD information from this document.

- Adjust funding profiles to support the balanced priorities. Address funding for producibility, LCC, implementation risk, application of open systems, and interoperability;

- Increase capability, within resource constraints, by using other S&T programs, acquisition investments, and commercial technology programs, in order to support performance and address the other goals; and

- Review programs with senior leaders to address affordability issues and the balance between near-term performance and TOCs.

The essential elements of the IPPD method are the following:

- Obtain senior leadership support for the balanced goals and the IPPD method;

- Develop the IPTs and the support and management processes needed to maximize their effectiveness (e.g., communication with IPT members, access to IPT information, tracking system for actions);

- Develop and execute a training plan for key IPPD participants from government and industry;

- Establish affordability metrics and a system for tracking program performance;

- Develop a transition plan that identifies the team members who will influence the transition and address the long-lead-time issues (e.g., funding) at the proper time; and

- Set up the senior leadership review process.

The IPPD method can be tailored to any program. The method can be a top-level process that helps implement the concepts we discuss in this *Manager's Guide*, including the following:

- Improved technology transition planning;

- Balanced consideration of performance and TOCs;

- Collaboration with other programs and industry to increase the solutions available to PMs;

- A high-performance IPT that can incorporate change rapidly and address all of the supporting issues (the second- and third-order effects of change). This is critical for reducing the disruption that accompanies change when transitioning technology.

Technology Readiness Levels

A key enabler for evolutionary acquisition and reduced cycle time is to have technology that is sufficiently mature to be fielded in a relatively short time. This requires having a method for measuring maturity, and a process for ensuring that technologies are sufficiently mature before being incorporated into systems that are being developed.

How does a PM determine that a technology developed by industry or a government laboratory is sufficiently ready or mature to transition to being used in a system? This is done by developing TRLs for each technology and applying them to determine whether the technology is ready for transition. Using TRLs for transitioning technology requires clear assignment of responsibilities and resources, and communication and interaction among the capability needs developers, acquisition community, and S&T managers.

Table 2-3 on the next page shows the *Defense Acquisition Guidebook* (formerly 5000.2R)[19] definitions of TRLs. The table lists the TRLs and descriptions from a systems approach for both hardware and software. DoD components may have additional clarifications for software. On the page following Table 2-3 is Table 2-4, which lists supplemental definitions for Tables 2-3 and 2-4.

In general, most S&T efforts stop at TRLs 4 through 6, where technology is validated in a lab or simulated operational environment. Thus, TRL 7, in which the technology is demonstrated in an operational environment, exceeds the normal S&T scope. At TRL 7, the technology has matured enough to transition to the acquisition community. The acquisition community then assumes all management, including planning for resources.

The key to transitioning technology — whether developed by industry or government — is the availability of sufficient funds to mature technology through later TRLs. Great ideas in the laboratory many times do not translate easily into workable DoD systems. Funds to mature and test these ideas are needed; however, the budget cycle for most programs requires as much as two years of planning before funds are available. Therefore, the technology provider and the PM must agree early and plan to prevent funding lapses during development.

Also, understanding that differences exist in the amount of risk that the government and industry accept in development and production programs is important. In general, the government accepts more risk than industry, particularly the non-defense commercial industry. What is considered a "ready to go" TRL 6–7 to the government may appear to industry as a "risky" TRL 2–3. Industry may seek contractual protection against the perceived technical and business risks for such a program.

Engineering and Manufacturing Readiness Levels (EMRLs)

The implication in the discussion of TRLs is that a technology at TRL 9 is ready for use and, therefore, ready for production. In many cases this may not be true. Nothing in the description of TRL 9 or the other TRLs requires that the technology be producible, reliable, and affordable. Consistent with the emphasis on including engineering, manufacturing, and sustainability issues early, the MDA extends the notion of TRLs to EMRLs. Unlike TRLs, the EMRLs are not yet endorsed in the DoD 5000 Series Regulations, but they can be a very useful tool when properly integrated into the IPPD.[20]

[19] *Defense Acquisition Guidebook, (DAG),* December 2004, available through link at http://akss.dau.mil/Guidebook.
[20] For a more detailed discussion of EMRLs, see Fiorino, Thomas D., Sr., Vice President, Andrulis Corporation, "Engineering Manufacturing Readiness Levels: A White Paper," October 30, 2001.

TRL	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples are paper studies of a technology's basic properties.
2. Technology concept or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and proof or detailed analysis might not be available to support the assumptions. Examples are limited to analytical studies.
3. Analytical and experimental critical function or characteristic proof of concept.	Research and development is initiated, including analytical and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Validation of component or prototype in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of ad hoc hardware in the laboratory.
5. Validation of component or prototype in relevant environment.	Fidelity of prototype technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System or subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle, or space. Examples include testing the prototype in a test-bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of system development. Examples include developmental tests and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proved through successful mission operations.	Application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

Source: *Interim Defense Acquisition Guidebook*, October 2002.

Table 2-3. Technology Readiness Levels

The Missile Defense Agency uses EMRLs to support assessments of systems engineering and design. EMRLs help assess the maturity of the design, related materials, tooling, test equipment, manufacturing, quality and reliability levels, and other characteristics necessary for a producible and affordable product. This approach, when used with TRLs, can ensure a more complete evaluation of the maturity of the system, component, or item. Table 2-5 describes each EMRL.

Consider designing EMRLs for your programs to enable better technology assessments, integrated with your IPPD processes.

SPECIAL CHALLENGES

Even with the tools for technology transition just described, PMs will encounter special challenges ranging from IP issues to incentives. This chapter concludes with a discussion of those challenges along with suggestions about how to overcome them.

Brassboard: An experimental device (or group of devices) used to determine feasibility and to develop technical and operational data. It normally is a model sufficiently hardened for use outside of laboratory environments to demonstrate the technical and operational principles of immediate interest. It may resemble the end item, but is not intended for use as the end item.

Breadboard: Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.

"High fidelity": Addresses form, fit, and function. High-fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.

"Low fidelity": A representative of the components or system that has limited ability to provide anything but first order information about the end product. Low-fidelity assessments are used to provide trend analysis.

Model: A functional form of a system generally reduced in scale, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

Operational environment: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.

Prototoype: A physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item, or system.

Relevant environment: Testing environment that simulates the key aspects of the operational environment.

Simulated operational environment: either 1) A real environment that can simulate all of the operational requirements and specifications required of the final system; or 2) A simulated environment that allows for testing of a virtual prototype. In either case, used to determine whether a developmental system meets the operational requirements and specifications of the final system.

Table 2-4. Definitions used in the TRL and EMRL Matrices

Intellectual Property

In the past, DoD usually funded the programs that led to new technology. Further, the government tended to acquire technical data and computer software and patent rights for ensuring long-term competition and supporting fielded systems. Today, the reverse is largely the case. Technology leadership has shifted to industry where most R&D dollars are spent. DoD now relies on market forces for competition and commercial technical manuals and instruction booklets for support.

Today, DoD must find ways to encourage commercial industry into collaborating with the Department in vital research, and to acquire commercial products using commercially friendly terms. Despite legislation in the 1990s that streamlined acquisition, helping to create contracting processes for the government more like commercial contracting, some practices are still in place that represent holdovers from past decades. One such holdover policy relates to IP.

EMRL	Description
1. System, component, or item validation in laboratory environment or initial relevant engineering or breadboard, brassboard development.	Significant system engineering or design changes. System engineering requirements not validated. Physical and functional interfaces not defined. High program risk. Materials tested in laboratory environment. Machines and tooling demonstrated in laboratory environment. Manufacturing processes and procedures in development in laboratory environment. Quality and reliability levels and key characteristics not yet identified or established. Includes requirements of TRL 4 and TRL 5 as a minimum.
2. System or components in prototype demonstration beyond breadboard, brassboard development.	Many systems engineering and design changes. Systems engineering requirements validated and defined. Physical and functional interfaces not fully defined. High program risk. Risk assessments initiated. Materials initially demonstrated in production. Manufacturing processes and procedures initially demonstrated. Machines and tooling require major investment. Inspection and test equipment developed and tested in manufacturing environment. Quality and reliability levels and key characteristics initially identified. Includes requirements of TRL 6 as a minimum.
3. System component, or item in advanced development. Ready for low rate initial production.	Few systems engineering or design changes. Prototypes at or near planned system engineering for required performance levels for operational system. Physical and functional interfaces clearly defined. Initial risk assessments completed. Moderate program risk. Materials in production and readily available. Manufacturing processes and procedures well understood and ready for low rate initial production. Moderate investment in machines or tooling required. Machines and tooling demonstrated in production environment. Inspection and test equipment demonstrated in production environment. Quality and reliability levels and key characteristics identified, but not fully capable or in control. Includes requirements of TRL 7 as a minimum.
4. Similar system, component, or item previously produced or in production. System, component, or item in low rate initial production. Ready for full-rate production.	Minimal systems engineering or design changes. All systems engineering requirements met. Minimal physical and functional interface changes. Initial risk assessments complete. Low program risk. Materials available. Manufacturing processes and procedures established and controlled in production to 3-sigma level. Minimal investment required in machines or tooling. Machines, tooling, and inspection and test equipment deliver 3-sigma quality in production. All key characteristics controlled to 3-sigma level in production. Includes requirements of TRL 8 and TRL 9 as a minimum.
5. Identical system, component, or item previously produced or in production. System, component, or item in full-rate production.	No systems engineering or design changes. Identical system, component, or item in production or previously produced that met all engineering requirements for performance, quality, and reliability. Low program risk. Materials, manufacturing processes and procedures, inspection and test equipment, quality and reliability, and key characteristics controlled in production to 6-sigma level. Proven affordable product.

This table provided courtesy of the Missile Defense Agency.

Table 2-5. Engineering and Manufacturing Readiness Levels

The concept of IP is fundamental to a capitalist society. A company's interest in protecting its IP from uncompensated exploitation is as important as a farmer's interest in protecting his or her seed corn. Often companies will not consider jeopardizing their vested IP to comply with the government contract clauses. These clauses often give certain government rights to IP and are holdovers from the days when DoD was the technology leader and frequently funded research programs completely. We now must create a new environment for negotiating IP terms and conditions that promotes the true interests of the government — incorporating technologically advanced solutions into the weapons systems and management systems we deploy.

On September 5, 2000, the USD(AT&L) signed a policy letter announcing a shift in focus for negotiating IP contract terms with commercial firms that ordinarily do not do business with DoD. The letter began altering DoD's thinking and putting in place the mandate to develop training materials that will assist the acquisition community in negotiating IP contract terms. As a result, the USD(AT&L) created a guide for the defense acquisition community (i.e., contracting personnel, legal counsel, and PMs) and its industry partners as a tool for equipping them with new ideas and solutions for resolving IP issues that cause fissures during negotiations. The Guide was published in October 2001, and is available at http://www.acq.osd.mil/dpap/Docs/intelprop.pdf.

Subsequently, USD(AT&L) signed a letter on January 5, 2001, that furthered this initiative. In addition to directing that the Guide be published, the Under Secretary highlighted the importance of engaging in certain practices permitted by regulation, including the following:

- emphasizing the use of specifically negotiated license rights;[21]
- exercising flexibility when negotiating patent rights;
- using performance-based acquisition strategies that may obviate the need for data or rights; and
- acquiring only those data, or those rights to data, that are truly needed for an acquisition.

Balancing the protection of industry's IP and maintenance of the vital protections that DoD needs to support its equipment requires the PMs to strike a careful balance. On the one hand, military systems must be supportable. On the other hand, to attract the best technology for equipping warfighters, DoD must encourage commercial company involvement, including non-traditional companies, to the defense market. In striking this balance, defense officials must be creative in their approach and business strategies. The above-mentioned *IP Guide* should help acquisition teams negotiate IP rights using the flexibility inherent in the regulations.

The Importance of Identifying Requirements

DoD is a large organization with many entities that require, acquire, and use technology. Because of the multiple entities, technology providers in government and industry alike must find out what DoD needs. Defense contractors that have an existing relationship with government technology seekers can ascertain DoD's needs more easily. Many large defense companies have a staff of experienced personnel devoted solely to connecting their company's technology with DoD's needs. Because no single, comprehensive list of capability needs or requirements can be accessed or searched by potential technology providers, small businesses or large businesses that have not worked for DoD do not know where to get the information they need. The resulting inefficient use of time and resources frustrates industry and government technology providers, and denies the government access to all the technologies available for solving its problems.

Government organizations with technology requirements can increase their access to technology by enabling potential technology providers to identify needs more easily and to contact the right

[21] DFARS 227.7103-5(d), *Specifically Negotiated License Rights*, commonly referred to as "special licenses."

personnel to pursue opportunities. A Web site is not enough of an access point. Government technology users must get out and "contact" the providers in meetings and symposia, and should be available and responsive when the providers contact them.

While Web sites alone are not enough, they are a key entry point for those seeking information about government requirements. Government organizations should test their Web sites and see how they work. PMs should visit their own Web sites, follow the contact and business opportunity instructions, and evaluate what happens. If an e-mail contact is given, how long did it take to receive a reply after you sent your query? Was the answer responsive to the question? Many DoD Web sites no longer have comprehensive contact information. Does an appropriate way exist for technology providers to reach you?

PMs should also publicize Web sources that identify government needs. There are many Web sites that address government needs. Below we list five sites — one for each Service and the SBIR program — that have information about their programs and links to other sites that contain technology requirements. The SBIR program site is an excellent example of a Web site that integrates with an "800 number" help desk, and has comprehensive information available.

Defense Advanced Research Projects Agency — http://www.darpa.mil/.
Army Research Laboratory — http://www.arl.army.mil.
Air Force Research Laboratory — http://www.afrl.af.mil.
Small Business Innovation Research (SBIR) Program (for small businesses, covers all Services' SBIR Programs) — http://www.acq.osd.mil/sadbu/sbir.

Solicitation Methods

Having identified a need, how does a company make its products and services known to the government? In most cases, the government will ask for help through several solicitation methods.

Requests For Proposals (RFPs) are a solicitation method described in FAR Part 15 and are applicable to procurement contracts. Using performance-based statements of work, the government describes in the RFP the results desired — or the "what" — and allows the contractor to propose the "how" they will achieve the desired results. The FAR Part 15 prescribes standard proposal formats and discusses the process for resolving disputes or errors.

Broad Agency Announcements (BAAs) are a method for soliciting S&T and state-of-the-art goods or services competitively that are not related to developing a specific system or hardware procurement. BAAs are announced on the Federal Business Opportunities Web site[22] and are general in nature, identifying areas of research interest (including criteria for selecting proposals) and soliciting the participation of all offerors capable of satisfying the government's need. The selection of multiple proposals that offer unique and innovative ideas is expected if funds exist. Award instruments under BAAs include procurement contracts, grants, cooperative agreements, OTs for prototype projects, and TIAs. When a procurement contract will not be used, the solution should be a Research Announcement (RA).

If the government does not ask for help in an RFP or BAA, industry can create its own contracting opportunities by submitting unsolicited proposals to do R&D or to introduce a new

[22] http://www.fedbizopps.gov/

or improved item of potential interest to DoD. To be considered, a company's unsolicited proposal must offer the government a unique and innovative concept. The proposal should contain an abstract of the proposed effort, the method of approach, and the extent of the effort. The proposal should also contain a proposed price or estimated cost. If the proposal includes proprietary data, the company should protect against disclosure to third parties by clearly marking such data with a restrictive legend. For detailed guidance about preparing unsolicited proposals, see the publication *Selling to the Military*, available at http://www.acq.osd.mil/sadbu/publications/selling/.

Incentives

DoD often relies on private industry to provide leading-edge technologies at an affordable cost throughout a system's life cycle. Consequently, DoD's suppliers must be innovative, efficient, effective, and should be rewarded with properly constructed cash and non-cash incentives.

In the past, the government-contractor relationship has been characterized as problematic and adversarial. Disconnects existed between the contractual incentives for achieving the government's desired performance and the motivation of the contractor.

Properly structured contractual incentives, as part of the overall business relationship, can maximize value for all parties. Contractual incentives should target the business relationship between the government and the contractor in such a way as to produce maximum value for taxpayers, the contractor, the warfighter, and the organization pursuing its mission. DoD not only must improve its ability to use existing contractual incentives, but also must develop a range of new and innovative contractual incentives.

Currently, DoD's contract policies and methods contain certain disincentives to developing and inserting beneficial technologies. These disincentives can be present in the S&T, development, production, and support phases of a system's life cycle. Inserting technology to enhance a system's performance or capabilities generally is encouraged by contract policies and methods. However, technology insertion for reducing costs over the total life cycle often encounters financial disincentives because cost savings may lead to budget reductions that are undesirable from an agency's perspective.

Cash Incentives

There are also positive incentives. Milestone payments for completing an observable technical event is a method for giving the contracting parties incentives to strive for better research results while avoiding many FAR-based requirements that are in cost-type R&D contracts.

To expand DoD's access to commercial developers and their technology, commercial incentives should be used. Factors that affect a company's decision to participate in a government project include the solicitation method, instrument structure (including cash and non-cash incentives), and contract administration methods. A commercial incentive would increase the contractor's profit, market share, or IP rights.

Non-Cash Incentives

Enhanced communications might also give contractors more incentive to participate. For example, when the presolicitation information is exchanged, the government could share the technology roadmaps for DoD's critical future requirements and compare them with industry's plans for commercial technology development.

Another non-cash approach, award-term incentives, are designed to entice the contractor to transition the workload well, provide superior support, and control prices through extensions or reductions of the terms that are directly based on performance. When using award-term incentives, the government establishes objective performance parameters in the underlying contract and announces up front that it intends to shorten or lengthen the period of contract performance (to a minimum or maximum) according to the contractor's performance against the parameters. The objective of this tactic is to establish long-term contractor relationships with proven producers of products or services.

The award-term structure is similar to that for an award fee but the incentive is a performance period rather than cash. This is effective if performance metrics are objective and when a long-term business relationship is of value to the government and the contractor.

Points are awarded during each year of the contract depending on performance in each measurement category. Decisions about extending or shortening the contract are made each year according to a moving, multiyear average of the contractor's point total. Extensions can be set according to performance that exceeds requirements rather than just meeting them.

Ownership of IP without government licenses, or negotiation of fewer government IP rights, is yet another form of non-cash incentive.

Cost-Based Incentives

Share-in-Savings (SIS) provisions are cost-based incentives now referred to by DoD as "efficiency savings." An SIS contract encourages contractors to use their ingenuity and innovation to get the work done quickly and efficiently to share in the savings attributed to their planning and execution.

SIS provisions are best used when the anticipated ROI is large enough to make this a viable business proposition for the contractor. With this tactic, the risk shifts from the government to the contractor, with commensurate opportunity for the contractor to receive rewards for performing successfully. Because of the risks, a partnership between the government and the contractor is required. The idea is to allow the contractor to use ingenuity and innovation to efficiently deliver the requirement instead of the government dictating its preferred approach.

Currently, DoD is implementing DFARS coverage for contractors to share savings. Contractors are encouraged to reduce costs via an advance agreement. Contractor actions include reducing management costs, consolidating facilities, modernizing facilities, and outsourcing. Savings can be shared. Under proposed rules, the amount of shared savings cannot exceed 50 percent of the cost reduction realized over a period not to exceed 5 years.

Profit incentives are another form of cost-based incentive. DoD updated its weighted guidelines profit policy for the first time in 15 years as a result of a Defense Science Board (DSB) Task Force examining the financial health of the defense industry. As a result, the DFARS now includes a provision to increase the negotiated fee according to the contractor's use of innovative technology. This incentive is based on a congressional desire to encourage innovation and is completely consistent with DoD's objectives.

3

PROGRAMS THAT FACILITATE TECHNOLOGY TRANSITION

Transitioning technology does not come naturally and can be very difficult. To transition technology successfully requires positive actions by people interacting throughout the system. A marketplace for the technology and appropriate applications for those technologies are necessary. The following programs were specifically designed to assist the community with developing new technologies that could be successfully transitioned. In some cases, the programs offer another source of funds in addition to the specific program that supports the transition.

These programs are:

- Advanced Technology Demonstrations
- Advanced Concept Technology Demonstration Program
- Defense Production Act Title III Program
- Dual Use Science and Technology Program
- Joint Experimentation Program
- Manufacturing Technology Program
- Small Business Innovation Research Program
- Defense Acquisition Challenge Program
- Small Business Technology Transfer Program
- Technology Transition Initiative
- Value Engineering
- Warfighter Rapid Acquisition Programs

ADVANCED TECHNOLOGY DEMONSTRATIONS (ATDs)

Technology development benefits when the communities work as a team, beginning early in the process. ATDs are a process for managing S&T programs that brings the team together early and demonstrates a military capability in a joint warfighting experiment, battle lab experiment, demonstration, field test, or simulation. ATDs are used to accelerate the maturation of technology needed by warfighters for either next-generation systems or upgrades to existing

legacy systems. ATDs use the IPPD process to ensure collaboration between the communities — S&T, requirements/warfighter, R&D, T&E, sustainment, and industry. The collaboration and coordination result in early interaction and exchange between the communities, permit experimenting with technology-driven operational issues, weed out unattainable technologies as early as possible, and result in more focused requirements and capability documents.

This is a process, not a program. ATDs require planning, review, and approval at the Service or agency level. ATDs have a finite program duration, agreed-upon exit criteria, and typically require transition plans. Accordingly, ATDs require technologies that are mature enough to provide a capability that can be used or demonstrated during the demonstration period. Services and agencies must provide full funding for ATDs because no source of external funding exists for this process. Most ATDs are funded with 6.3 funds, respond to high-priority user needs, and have a funded target program (e.g., reflect a reasonable chance of transitioning to an acquisition program funded in the Future Years Defense Plan (FYDP)). ATDs also are reviewed to ensure that they do not duplicate other programs.

The ATD team evaluates technical feasibility, affordability, compliance with operational and technical architectures, operation and support issues, and user needs as early as possible. This fully integrated approach and focus on operationally sound capabilities ensures that militarily significant capabilities can be developed, evaluated, and transitioned to the warfighter rapidly.

Participation in the Program

Services and agencies have processes for nominating and approving ATDs and have plans for managing ATDs. In general, the senior research and technology manager in the organization manages ATDs. Typical requirements for participating in the program are the following:

- A concept that addresses established S&T objectives, and could provide a significant new or enhanced military capability or more cost-effective approach to providing the capability.

- A fully planned and funded program with a limited duration (usually less than five years, with shorter durations being better).

- Exit criteria and a transition plan that is supported by the user representative and the systems developer.

ADVANCED CONCEPT TECHNOLOGY DEMONSTRATION (ACTD) PROGRAM

In early 1994, the DoD initiated a program designed to help expedite the transition of maturing technologies from the developers to the users. The ACTD program was developed to help adapt the DoD acquisition process to today's economic and threat environments. ACTDs emphasize assessing and integrating technology rather than developing it. The goal is to give the warfighter a prototype capability and to support the warfighter in evaluating the capability. The warfighters evaluate the capabilities in real military exercises and at a scale sufficient to fully assess military usefulness.

ACTDs are designed to enable users to understand the proposed new capabilities for which there is no user experience. Specifically, ACTDs give the warfighter opportunities to:

- develop and refine the warfighter's concept of operations to fully exploit the capability of the technology being evaluated;

- evolve the warfighter's operational requirements as the warfighter gains experience and understanding of the capability; and

- operate militarily useful quantities of prototype systems in realistic military demonstrations and, on that basis, assess the military usefulness of the proposed capability.

An ACTD can have one of three outcomes. The first outcome is that the user sponsor may recommend acquiring the technology and fielding the residual capability that remains after the demonstration phase of the ACTD to provide an interim and limited operational capability. If the capability or system does not demonstrate military usefulness, the second outcome is that the project is terminated or returned to the technology base. A third outcome is that the user's need is fully satisfied by fielding the capability that remains when the ACTD is concluded, and no additional units need to be acquired.

There are several major differences between ACTDs and ATDs. ACTDs are programs usually employing multiple technologies, which are reviewed by OSD and the Joint Requirements Oversight Council (JROC) and funded (in part) with OSD ACTD funds. An ATD is actually a process for managing selected high-priority S&T programs. ATDs are reviewed and approved by the Services, and funded with Service S&T funds.

ACTDs should work with relatively mature technologies to improve the probability of success and the likelihood of transitioning the technology into programs. A recent GAO report addresses this and other factors affecting ACTDs' success.[1] This GAO report concludes ACTD outcomes can be improved, while noting that the majority of the ACTDs examined did transition some technologies to the user. The GAO report found that:

- some technology was too immature to be effectively demonstrated in the hands of the warfighter, leading to cancellations of demonstrations;

- Services did not provide follow-on funding for some successful ACTD technologies; and

- military utility assessments required in ACTDs have not been done consistently.

ACTDs should consider manufacturing and sustainment issues as a part of their programs. The long-term success of ACTD initiatives can be improved by considering all of the manufacturing, sustainment, and operational and support issues.

[1] GAO Report GAO-03-52, *Defense Acquisitions: Factors Affecting Outcomes of Advanced Concept Technology Demonstrations*, December 2, 2002.

Participation in the Program

The Deputy Under Secretary of Defense for Advanced Systems and Concepts (DUSD(AS&C)) is responsible for selecting and approving ACTDs. Ideally, a user-developer team, having combined a critical operational need with maturing technology, will develop an ACTD candidate for consideration. The Director, Defense Research and Engineering (DDR&E) Advanced Systems and Concepts (AS&C) staff is available to assist the team with developing and refining the concept and clarifying the ACTD's basic criteria and attributes. When the details of the concept are defined, a briefing is presented to the DUSD (AS&C). The concept may be accepted for further discussion, deferred with guidance for refinement, or rejected. If accepted, a briefing is presented to the "Breakfast Club," an advisory group of senior acquisition and operational executives, for their review and assessment. The candidate ACTDs then are presented to the Joint Staff, through the Joint Warfare Capabilities Assessment (JWCA) and the Joint Requirements Oversight Council (JROC), for their review and recommended priority. Based on these assessments, the DUSD(AS&C) makes the final funding decisions about the ACTDs.

According to an October 30, 2001, memorandum, "ACTD proposals should address the Department's most pressing and urgent military issues. Additionally, they should support the Department's transformation goals and objectives. All proposals should begin with a statement of the problem they intend to solve and the proposed capabilities addressing this problem."[2]

The ACTD Web site — http://www.acq.osd.mil/actd/ — is another source of information about ACTDs.

THE ACTD "BOOT CAMP"

The Defense Acquisition University is developing an intense, hands-on, practitioner-targeted training program for ACTD management teams. Currently billed as an "ACTD Boot Camp" and scheduled for rollout in FY05, this training program will offer real time, subject matter expert-facilitated development of the ACTD documentation package with particular emphasis on the ACTD Management Plan. The "Boot Camp" will consist of a distance learning phase, which all participants will complete prior to attendance at the on-site portion. Covering the critical concepts and processes vital to successful ACTD management, the distance learning phase, will ensure that all participants are equipped with the requisite baseline level of knowledge and skills. The on-site phase will be a highly interactive, fast-paced application of ACTD management concepts, processes, and resources all directly tailored to the ACTD of the attending management team. Upon completion of the "Boot Camp" the ACTD management team will return to their home station with a jump start on their documentation package and at least a draft of the overall ACTD Management Plan. Log onto http://www.dau.mil for the latest information on the debut of the ACTD Boot Camp.

ACTD TRANSITION AND TECHNOLOGY MANAGERS COURSE

This course was developed under the auspices of DDR&E(AS&C). The purpose of the course is to introduce and familiarize ACTD management teams with the expectations and requirements of programs that operate within the DoD Acquisition Framework and to help teams plan for transition to acquisition. Many, perhaps most, ACTD projects expect to eventually transition from the Science and Technology environment into acquisition, either becoming stand-alone acquisition programs or integrating into larger programs. This transition can be difficult to

[2] DUSD(AS&C), *Fiscal Year 2003 Advancement Concept Technology Demonstration (ACTD) Proposals*, Office of the Under Secretary of Defense, October 30, 2001.

impossible if the ACTD management team does not understand the acquisition environment, and the planning for transition must begin as soon as the ACTD project is approved. This course includes familiarization with a number of DoD acquisition topics and the demands likely to be made on ACTD programs as they transition to acquisition. In addition, presentations by experts from ACTD Oversight Executives and representatives from Joint Forces Command (JFCOM) provide insight into the requirements and expectations associated with developing ACTD transition plans and managing the transition of Joint Services ACTDs under the guidance of JFCOM.

DEFENSE PRODUCTION ACT TITLE III PROGRAM (Title III)

The mission of the Defense Production Act Title III Program (Title III) is to create assured, affordable, and commercially viable production capabilities and capacities for items that are essential to the national defense. By stimulating private investment in key production resources, Title III helps to:

- increase the supply, improve the quality, and reduce the cost of advanced materials and technologies needed for the national defense;

- reduce U.S. dependence on foreign sources of supply for critical materials and technologies; and

- strengthen the economic and technological competitiveness of the U.S. defense industrial base.

Title III activities lower defense acquisition and LCCs and increase defense system readiness and performance by using higher quality, lower cost, and technologically superior materials and technologies.

Title III authority can be used to address the following:

- Technological obsolescence, i.e., when a newer technology replaces an older one and the capability to produce the older technology falls into disuse and is gradually lost. By using Title III authority, flexible manufacturing capabilities can be created to produce aging technologies efficiently and affordably. Alternatively, the authority can be used to consolidate and maintain production capabilities that otherwise would be lost because of changing market conditions, even though such capabilities are still needed for defense and still can be operated efficiently and profitably.

- Low or irregular demand (i.e., when the demand for an item is inadequate to support continuous production), so the delivery of the item is delayed because of the time needed to obtain materials for producing the item or for the time needed by the production queuing. Title III purchase commitments can be made to consolidate and level demand for key production capabilities, which gives suppliers incentives to maintain and upgrade these capabilities, and to respond to defense acquisition needs in time. Purchase

commitments can also be used to reserve production time to ensure timely access to production resources for fabricating critical defense items.

- Producers exiting the business, i.e., when companies go out of business or drop product lines that no longer fit their business plans. Title III authority can be used to support transferring production capabilities to new sources.

Participation in the Program

Virtually all Title III projects promote integrating commercial and military production to lower defense costs and enable earlier defense access to, and use of, emerging technologies. The production for both military and civilian markets represents a new thrust for the Title III program, and is referred to as "dual produce." A government–industry working group identifies dual-produce projects, develops a list of general project areas, and publishes a BAA based on the list to solicit proposals from industry and DoD organizations. Projects are selected according to potential cost savings — both direct savings from the projects themselves and indirect savings from the broader application of demonstrated capabilities to other defense items.

The Title III program is a DoD-wide initiative under the DDR&E. Management responsibilities include program oversight and guidance, strategic planning and legislative proposals, approval of new projects, and liaison with other federal agencies and Congress.

The Air Force is the executive agent for the program in DoD. The Title III program office at Wright-Patterson Air Force Base, OH, is a component of the Manufacturing Technology Division of the Air Force Research Laboratory (AFRL). The program office identifies and evaluates prospective Title III projects, submits projects for DDR&E's approval, structures approved projects, implements contracting and other business actions for the projects, oversees active projects, provides for selling and using materials acquired through Title III contracts, and does the planning and programming support for DDR&E. For further information about the DoD Title III program, visit http://www.dtic.mil/dpatitle3/.

DUAL USE SCIENCE AND TECHNOLOGY (DUS&T) PROGRAM

A dual-use technology is one that has both military utility and sufficient commercial potential to support a viable industrial base. Funding for this program has shifted from OSD to the Services. The government objectives of the DUS&T program are the following:

- Partnering with industry to jointly fund the development of dual-use technologies needed to maintain DoD's technological superiority on the battlefield and industry's competitiveness in the marketplace.

- Making the dual-use development of technologies with industry a normal way of doing business in the Services.

These objectives are met by using streamlined contracting procedures and cost sharing between OSD, the Services, and industry.

The industry objective for the program is to achieve the following benefits:

- leverage scarce S&T funding;

- be a vehicle for forming beneficial partnerships with other firms, defense labs, or universities;

- gain access to advanced technology; and

- increase the potential for transitioning technologies to defense systems, which can lead to increased markets.

The recently published DoD Guide to developing dual-use technology highlights the advantages of fostering these kinds of relationships.[4]

JOINT EXPERIMENTATION (JE) PROGRAM

Joint experimentation is defined as the application of scientific experimentation procedures to assess the effectiveness of proposed (hypothesized) joint warfighting concept elements to ascertain if elements of a joint warfighting concept change military effectiveness.[5] The U.S. Joint Forces Command (USJFCOM) leads the JE program, with support from the Joint Staff, other Combatant Commands, Services, and defense agencies. The Joint Experimentation program examines new warfighting concepts and techniques, either by Modeling and Simulation (M&S) or through exercises with actual forces. The results of the experiments are used to shape the concepts, doctrine, and materiel systems requirements for the future joint force. One of the focus areas is joint interoperability to ensure that our Service capabilities operate as one unified force during future conflicts. Selected high-payoff technologies may be examined during the JE. This program works closely with the ACTD program, assisting with improving and demonstrating ACTD products.

Participation in the Program

The JE program has limited funding. The majority of the funding is used to assist the military units involved to participate and support the events. In general, candidate technologies must address major future joint force capability shortfalls. The technology must be sufficiently mature to demonstrate in an actual exercise. In certain cases, surrogate capabilities may be used, or the system may be represented in computer simulations. Entry is easiest for contractors that submit a fully funded proposal.

The J-9 (Joint Experimentation) staff at USJFCOM, Norfolk, VA, has more information about opportunities and needed capabilities. Each Service has its own experimentation programs and participates in the JE program. The relevant Service experimentation point of contact (e.g., U.S. Army Training and Doctrine Command (TRADOC)) can provide information about opportunities.

MANUFACTURING TECHNOLOGY (ManTech) PROGRAM

The DoD ManTech program focuses on the need of weapons system programs for affordable, low-risk development and production. The program is the crucial link between technology invention and development, and industrial applications. The program matures and validates

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[4] DUSD(S&T), Office of Technology Transition, *Dual-Use Science and Technology Process: Why Should Your Program Be Involved? What Strategies Do You Need to Be Successful?* July 2001. Available online at http://www.dtic.mil/dust.

[5] U.S. Joint Forces Command, *Joint Forces Command Glossary*, accessed August 4, 2002, at http://www.jfcom.mil/about/glossary.htm#JE.

emerging manufacturing technologies to support low-risk implementation in industry and DoD facilities, e.g., depots and shipyards. The program addresses production issues beginning during the development of the technology. The program continues to support the system during the transition into its production and sustainment phases. By identifying production issues early and providing timely solutions, the ManTech program reduces risk and improves affordability by addressing potential manufacturing problems before they occur. The program vision is to realize a responsive, world-class manufacturing capability to affordably meet the warfighters' needs throughout the defense system life cycle.

The ManTech program uses technology created throughout the S&T base and works with performance technology demonstrations; weapons system development, production, and support; and acquisition reforms, including those for defense use of commercial items and specifications. The ManTech program collaborates with many DoD activities. Collaborative efforts also include non-DoD organizations, such as the National Aeronautics and Space Administration (NASA), Department of Commerce (DOC), Department of Energy (DOE), and the National Science Foundation (NSF). The three military departments (Army, Navy, and Air Force), the Defense Logistics Agency (DLA), and DARPA execute the program. The Deputy Under Secretary of Defense for Advanced Systems and Concepts (DUSD(AS&C)) manages the program.

Participation in the Program

A unified planning process is used to identify and prioritize weapon system requirements and the pervasive needs of the industrial base to support those requirements. The Joint Defense Manufacturing Technology Panel (JDMTP), its four subpanels, and its two ad hoc working groups coordinate the planning. The National Center for Advanced Technologies facilitates the panel's interaction with industry. By analyzing the requirements and technology base efforts, technological opportunities (projects) with direct application to DoD needs are identified for potential ManTech program investment.

For component-unique projects (i.e., those affecting the needs of only one Service), the individual component executes and implements the project. For more pervasive or joint projects, DARPA, one of the Services, or DLA is designated as the lead depending on internal capability or ownership of the first demonstration application. A variety of activities are used for doing ManTech projects. These include centers of excellence, consortia, private industry, academia, and government facilities. For more information about the ManTech program, visit http://www.dodmantech.com/index.shtml.

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

Congress created the SBIR program in 1982 to help small businesses participate more in federal R&D. Each year, 10 federal departments and agencies are required to reserve part of their R&D funds for awarding to small businesses under the SBIR program. Participating departments and agencies include: Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Transportation, the Environmental Protection Agency (EPA), NASA, and NSF.

DoD's SBIR program funds early-stage R&D projects at small technology companies — projects that serve a DoD need and could be commercialized in the private-sector or military markets. The program, funded at approximately $773 million in FY02, is part of the larger ($1.5 billion) federal SBIR program.

The Small Business Innovation Research Program Act of 2000,[6] extended the SBIR program's authorization to September 30, 2008. According to congressional findings reported in the act, "the SBIR program made the cost-effective and unique research and development capabilities possessed by the small businesses of the nation available to federal agencies and departments," and "the innovative goods and services developed by small businesses that participated in the SBIR program have produced innovations of critical importance in a wide variety of high-technology fields, including biology, medicine, education, and defense."[7]

Congress further states, "the SBIR program is a catalyst in the promotion of research and development, the commercialization of innovative technology, the development of new products and services, and the continued excellence of this nation's high-technology industries…The continuation of the SBIR program will provide expanded opportunities for one of the nation's vital resources — its small businesses; will foster invention, research, and technology; will create jobs; and will increase this nation's competitiveness in international markets."[8]

As part of its SBIR program, the DoD issues an SBIR solicitation twice a year, describing its R&D needs and inviting R&D proposals from small companies, i.e., firms organized for profit with 500 or fewer employees, including all affiliated firms. Companies apply first for a six-month Phase I award of $60,000 to $100,000 to test the scientific, technical, and commercial merit and feasibility of a particular concept. If Phase I is successful, the company may be invited to apply for a two-year Phase II award of $500,000 to $750,000 to further develop the concept, usually to the prototype stage. Proposals are judged competitively on the basis of their scientific, technical, and commercial merit. After Phase II is completed, companies are expected to obtain further funding from the private-sector or non-SBIR government sources (in Phase III) to develop the concept into a product for sale in private-sector or military markets.

Participation in the Program

Eligible companies must have no more than 500 employees and must be the primary place of employment of the principal investigator. In addition, the companies must be American-owned and independently operated, and a for-profit entity.

Each of the 10 federal departments and agencies accepts proposals and selects their own R&D topics for the SBIR program. The Small Business Administration (SBA) collects solicitation information from all participating agencies and publishes it quarterly in a pre-solicitation announcement at http://www.sbaonline.sba.gov/sbir/indexprograms.html.

After proposals are submitted, agencies make SBIR awards according to the qualification, degree of innovation, technical merit, and future market potential of each small business. Small businesses that receive awards or grants then begin a three-phased program.

Appendix C describes a number of successes achieved by small business participants in the SBIR program. For more information about the program, visit http://www.sba.gov/sbir/indexsbir-sttr.html.

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[6] P.L. 106-554, Appendix 1 — HR 5667, Title 1, accessible at http://www.acq.osd.mil/sadbu/sbir/pl106-554.pdf on August 1, 2002.
[7] *Ibid.*, Section 102.
[8] *Ibid.*

DEFENSE ACQUISITION CHALLENGE PROGRAM (DACP)

The Defense Acquisition Challenge Program (DACP) is a program authorized by the FY03 National Defense Authorization Act.[9] The Secretary of Defense (SECDEF), acting through the USD(AT&L), will establish a program for providing opportunities for increasing the introduction of innovative and cost-saving technology in DoD's acquisition programs.

The Defense Acquisition Challenge Program will give people or organizations inside or outside DoD the opportunity to propose alternatives, known as challenge proposals, at the component, subsystem, or system level of an existing DoD acquisition program. Challenge alternatives should improve the performance, affordability, manufacturability, or operational capability of the program.

The challenge proposal will be evaluated to determine whether the proposal:

- has merit;
- is likely to improve performance, affordability, manufacturability, or operational capability at the component, subsystem, or system level of an acquisition program; and
- could be implemented in the acquisition program rapidly, at an acceptable cost, and without unacceptable disruption to the program.

For more information on DACP, visit http://www.acq.osd.mil/asc.

SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) PROGRAM

The STTR program is a small business program that expands funding opportunities for federally sponsored, innovative R&D. Central to the program is the expansion of the public and private-sector partnership, including joint venture opportunities for small businesses and the nation's premier non-profit research institutions. The program's most important role is to foster the innovation necessary to meet the nation's S&T challenges.

Small business has long been where innovation and innovators thrive, but the risk and expense of doing serious R&D can be beyond the means of many small businesses. Conversely, non-profit research laboratories are instrumental in developing high-tech innovations, but frequently their innovation is confined to the theoretical rather than the practical. STTR combines the strengths of both entities by introducing entrepreneurial skills to high-tech research.

Each year, five federal departments and agencies (the Departments of Defense, Energy, Health and Human Services; along with NASA and NSF), are required under the STTR program to reserve part of their R&D funds for award to partnerships between small businesses and non-profit research institutions.

Participation in the Program

Small businesses must meet certain eligibility criteria to participate in the STTR program. They must be:

[9] See the *Defense Acquisition Challenge Program*, Section 243, NDAA for FY03.

- American-owned and independently operated,
- for-profit, and
- have no more than 500 employees.

A non-profit research institution also must meet certain eligibility criteria. Although there is no size limit, it must:

- be based in the United States, and
- meet one of three definitions: (1) non-profit college or university, (2) domestic non-profit research organization, or (3) Federally Funded R&D Center (FFRDC).

Each of the five participating federal departments and agencies accepts proposals and designates its own R&D topics for the STTR program. The SBA collects solicitation information from the participating agencies and publishes it periodically in a pre-solicitation announcement. The SBA's pre-solicitation announcements, available at http://www.sbaonline.sba.gov/sbir/indexprograms.html, are the single source for the topics and anticipated release and closing dates for each agency's solicitations.

After proposals are submitted, the agencies make STTR awards based on the qualifications of the small business or non-profit research institution, degree of innovation, and future market potential. Small businesses that receive awards or grants then begin a three-phased program.

Phase I is the startup phase. Awards of as much as $100,000, for approximately one year, fund the exploration of the scientific, technical, and commercial feasibility of an idea or technology. Phase II awards of as much as $500,000, for as long as two years, expand Phase I results. During this period, the R&D is done and the developer begins to consider commercial potential. Only Phase I award winners are considered for Phase II. Phase III is the period during which Phase II innovation moves from the laboratory into the marketplace. No STTR funds support Phase III. The small business must find funding from the private sector or a non-STTR federal program. For more information about the STTR program, visit http://www.sba.gov/sbir/indexsbir-sttr.html.

TECHNOLOGY TRANSITION INITIATIVE (TTI)

The TTI is an FY03 National Defense Authorization Act (NDAA)-initiated program, which provides limited funding for selected technology transition projects. The objective of the TTI is to accelerate the transition of S&T mature technologies into the acquisition/procurement process to enhance the operational capabilities within the Services.

The TTI program is administered by a TTI PM within the Office of the Deputy Under Secretary of Defense for Advanced Systems and Concepts (DUSD(AS&C)).

The Services, defense agencies, and the Combatant Commands may nominate projects for implementation under this initiative.

The TTI PM funds the projects that have the highest value to DoD based on the advice and assistance of the Technology Transition Working Group (TTWG), which represents the

Technology Transition Council (TTC). The Service Acquisition Executives (SAEs), the JROC, the Commanders of the Combatant Commands, and the S&T executives from the Services and defense agencies are members of the TTC. If the projects are selected, TTI will fund 50 percent or more of the cost of the project for up to four years.

The funding for this program is limited and mature technologies selected for TTI participation must have a clear path into the formal acquisition framework. The TTI is a way for selected programs to receive funding to accelerate a transition needed to get a product to the field. This program supplements, rather than replaces, existing Service and defense agency technology transition programs.

Participation in the Program
For more information on the TTI program and examples of currently funded programs, visit its Web site at http://www.acq.osd.mil/iti/about.html.

VALUE ENGINEERING (VE)
VE has two aspects: a financial incentive to get contractors and subcontractors to reduce the cost of DoD's systems, supplies, and services and a rigorous method for maximizing cost savings. Contractors who participate in VE share in net savings on the basis of their financial risk. If, for example, a contractor funds the cost for developing a VE idea, the share is normally 50 percent; if the government funds the idea development cost initially, the contractor receives 25 percent of net savings. Exact shares are defined in the Federal Acquisition Regulation. VE is unique because it maintains essential functions and lowers overall cost without degrading performance, reliability, maintenance, or safety. To qualify as VE, an idea must, at a minimum, result in a change in a support contract that, when implemented, saves money. A VE incentive clause is required in non-R&D contracts of more than $100,000 and can be requested in smaller ones.

After the contract is awarded, the contractors have little reason to reduce acquisition or life cycle cost. In fact, without VE, contractors lose money by reducing costs. Because profits are derived from cost, reducing cost without VE reduces profits. With VE, however, the situation is reversed. Contractors keep their original profit and share in net savings in four areas: their existing contract, concurrent contracts (such as Foreign Military Sales (FMS)), future contracts (normally for three years), and collateral (O&S) savings.

Participation in the Program
Contractors are encouraged to participate in the VE program by submitting cost-reduction ideas as Value Engineering Change Proposals (VECPs) pursuant to FAR 52.248-1. Contractors who voluntarily use their own resources to develop and submit VECPs gain the most, sharing 50 percent of the savings. If a VECP is not approved, however, the government does not reimburse a contractor's development cost. This was added to the FAR to ensure that only high-quality VE ideas are proposed. VE savings typically are shared for three years after acceptable implementation. Contractors share net savings on their existing contract, concurrent contracts, and on future collateral savings. Collateral savings are measurable net reductions in an agency's overall projected operations, maintenance, logistics support, or government-furnished property costs. Because collateral savings are auxiliary savings, and at best a prediction of future possibilities, the share is smaller — 20 percent of a typical year's operations and support savings, not to exceed the price of the existing contract price or $100,000, whichever is more. VE sharing is limited to contracts issued by the procuring office or its successor. Each buying activity funds

its own VECPs and may not buy a VECP unless funds are available to develop and implement the idea. Similarly, the government may not disapprove a VECP and then use the idea. When a contractor is unfamiliar with VE, or cannot afford to voluntarily do VE, the government may choose to require a mandatory VE program. When this occurs, the government funds the entire VE process from idea generation to implementation. Because the government is accepting the full financial risk for mandatory VE, contractors share at a lower rate of 25 percent of net savings per FAR 52.248-1.

WARFIGHTER RAPID ACQUISITION PROGRAM (WRAP)

The Army established the WRAP to address the gap in funding that exists because of the time required to plan, program, budget, and receive appropriations for procuring a new technology. WRAP was designed to shorten the acquisition cycle and be a bridge between experimentation and systems acquisition. The goal was to put new weapons in the hands of soldiers faster and cheaper. Candidates for the WRAP were selected according to urgency of need, technical maturity, affordability, and effectiveness. To promote program stability, candidates received funding for the first two years, which allowed time to build them into the overall budget.

The Army used WRAP for several programs: the Stryker, its new lightweight combat vehicle; the lightweight laser designator rangefinder, used to determine the range of a target and relay that information back to tanks, artillery, or aircraft; and radio frequency tags, a computer tracking system used to pinpoint equipment quickly and easily. The Army is no longer funding WRAP, but is developing other initiatives to rapidly transition technology to warfighters.

The Air Force Warfighter Rapid Acquisition Process (AF WRAP), which is an ongoing program, is a rigorous process that speeds the initial acquisition decision and allocation of funds for a small number of competitively selected projects that either increase warfighter capability or significantly reduce costs. AF WRAP can accelerate implementing and fielding of projects meeting the immediate needs of the warfighter. AF WRAP quickly makes available newly matured, often pivotal technology. The AF WRAP candidate review ensures the smooth transition of selected candidates to operational capabilities that are acquired and sustained as part of the baseline Air Force program.

WRAP funding is allocated in the execution year to support selected projects for as long as two years. Major commands selected to receive FY02 WRAP funds have committed to funding, developing, procuring, and sustaining their selected project.

AF WRAP candidates approved in FY02 include the Panoramic Night Vision Goggles (PNVG), increasing night vision goggle field of view from 40 to 100 degrees; the remote casualty locator and assessment device, a low-cost, hand-held, battery-powered device that enables the user to "see" through walls, rubble, wood, and earth to locate and assess the condition of casualties; and the Information For Global Reach — Aerovac, which provides continuous, seamless exchange of mobility- and medical-related C2 and patient health information among fixed, airborne, deploying, and deployed mobility and medical elements.

4

CHALLENGES AND CONSIDERATIONS

This chapter identifies some of the issues that will be faced during the technology transition process. The issues were developed from questions and feedback received from government and industry technology transition personnel. For each of the issues, we pose a series of questions for the communities that form the technology transition team. Following each question is a short answer that contains information for your consideration. As with all advice, these considerations must be reviewed to ensure that they apply to your specific situation and program.

Tables 4-1 through 4-3 summarize the contents of this chapter, to assist you in locating specific issues.

Table 4-1. Issue Category 1: Technology Transition

Table 4-1. Issue Category 1: Technology Transition (Continued)

Table 4-1. Issue Category 1: Technology Transition (Continued)

Table 4-2. Issue Category 2: Cultural Barriers

Table 4-3. Issue Category 3: Knowledge Management

During the S&T phase of a system's development in government, industry, or academia, the focus is on developing knowledge. In the PM[1] community, the focus is on applying technology to improve the performance, operations, or affordability of specific products. The transition between these two phases requires a partnership among many communities: S&T, R&D, PMs, capability needs, T&E, sustainment, and financial. The transition must be managed to ensure that the warfighters receive the greatest benefit from current technology development.

This chapter describes the questions and challenges that arise during this transition, and suggests ways to address and resolve the challenges. The challenges, which address systematic problems

[1] PM in this chapter means acquisition program managers.

about transitioning technology that pervade acquisition and sustainment, are organized into these broad categories:

1. **Technology Transition**: How to quickly deploy a useful military capability to the field and upgrade that capability in later stages of a system's life cycle.

2. **Cultural Barriers**: How to overcome the disincentives, communication shortfalls, and suboptimization that occurs among the different communities that interact in technology transition.

3. **Knowledge Management**: How to identify useful information and activity that occurs in the different communities and share that information in ways that support technology transition.

The discussion of these challenges is organized around a series of questions that are relevant for each of the communities involved in that issue — capability needs, S&T, R&D, acquisition, T&E, financial, and sustainment. In response to the questions, information is offered about policies, procedures, and management techniques that address the related issue.

ISSUE CATEGORY 1: TECHNOLOGY TRANSITION

Issue 1-A: Inserting Enabling Technology

One of the major challenges facing DoD is modernizing legacy systems using state-of-the-art technology. Therefore, from the start of an acquisition program, DoD must consider not only how to get a useful military capability to the field quickly, but also how it can upgrade a system later. Considerations include the latest technology, increasing mission performance, reducing O&S costs, and enhancing supportability.

Although basic and applied research are the foundations for meeting future technology needs, other programs — such as ATDs, ACTDs, warfighter experiments, and other approaches — are key to accelerating the transition from S&T to military weapons systems. Managers of S&T, R&D, and acquisitions must collaborate on their efforts if a technology is to be transitioned into weapons systems. For example, the Air Force Applied Technology Council (AF ATC) specifically calls for a review and technology transition plan for each ATD. The Air Force collaborator program is another means of connecting the S&T community with users in particular technology areas. Below are some questions that must be considered for inserting technology.

CONSIDERATIONS

Capability Needs Community

Do your capability needs documents describe the essential warfighting capabilities, but give the developer the maximum possible flexibility for selecting technologies to meet the need?

Capability needs documents should contain as few Key Performance Parameters (KPPs) as possible while ensuring an effective, interoperable system for the warfighter. The KPPs should be written so all appropriate technologies can compete. The non-KPP needs should be added judiciously, even though they are in the "trade space." Capability needs writers should avoid repeating boilerplate requirements from legacy Operational Requirements Documents (ORDs). Including seemingly innocuous "standard" requirements may have unintended consequences, and unnecessarily add to the developmental time, testing, and cost of a system.

Do your capability needs documents employ an incremental approach to support evolutionary acquisition and spiral development?

The joint requirements community is attempting to make evolutionary capability needs the rule, rather than the exception, for major systems. A solution that is 60 to 80 percent complete in the hands of a warfighter in combat is better than a 99 percent solution that is still being developed. By using incrementally phased capability needs a system can be fielded and improved as technology matures. The phases should be developed in cooperation with the S&T, R&D, and acquisition communities, and should reflect appropriate analyses of the cost-benefit trade-offs.

Do your capability needs documents support technology transition, especially technologies that reduce life cycle costs?

As part of interoperability, capability needs documents should encourage using open architectures, open interface standards, and alternatives that support inserting technology throughout the life of the system. Many times, PMs prioritize technologies that reduce cost or improve performance in the near term instead of technologies that reduce life-cycle cost. The capability needs community should examine these priorities, and ensure that technologies that reduce the life-cycle cost are given the appropriate priority — even though they may not offer as great a near-term benefit. Because major systems will be out in the field for decades, they must be as capable and economical as possible, for as long as possible.

Are you involved in S&T planning and investment?

Users (also known as "warfighters" or "combat developers") should participate, as appropriate, in S&T planning. Users provide information about future warfighting concepts, plans for new systems, and recommendations about S&T priorities. S&T programs need some flexibility to pursue information about subjects that currently do not line up with planned developmental programs. Applying appropriate resources to supporting critical future warfighting needs and transition issues must be balanced with investing in items that have a near-term payoff.

Are the capability needs documents available for supporting transition?

Sometimes, in programs like ACTDs, organizations fail to plan ahead and anticipate the need to rapidly transition an S&T effort into an acquisition program. Capability needs documents are not required for ACTD programs but are necessary for transitioning the ACTD systems into mainstream acquisition. This transition may require assessing and analyzing alternatives concurrently with the ACTD so the necessary analytical framework for the capability need will be ready. The schedule for capability needs documents should be an integral part of the planning for the transition.

S&T Community

Are technology programs prioritized on the basis of the scheduled needs and aligned with needs in the potential user programs?

Technology projects should be prioritized according to the warfighters' projected needs and reviewed by them periodically. S&T leaders, warfighters, and the acquisition or sustainment PMs should do the review annually, and projects should be funded according to the priorities established. As a means of forcing new ideas, all programs should be evaluated for relevance and

productivity. One way of forcing ideas is to eliminate the least productive projects annually, which will keep the technology more current.

Once technologies are prioritized and funded, the phasing of development and upgrades to weapons systems must be considered. Technology developments must be synchronized to meet acquisition program milestones and the need for any incremental upgrades. Therefore, involving the users early, and planning strategically, is critical — technology projects should be managed with the warfighter mission in mind.

Planning for technology requires integrating warfighter needs with resources and technology opportunities. Planning should start early and outline probable paths for transition. In addition, all representatives from acquisition programs, industry, and other expert peers should participate in the planning. After the stakeholders, including the warfighter, have planned the technology and agreed to the plan, the technology can be developed. While the technology is being developed, it continues to be reviewed in the technology prioritization process and the plan is linked to the budget and the investment decisions. Planning is important because it provides structure to investing, shows where funding will occur, and gets commitments for resources and programs.

Do you have strategies and techniques for pushing government-funded technology to commercial venues and to ensure that government rights are protected?

Technology transferred to the commercial sector maximizes the government's benefits from investing in technology. By transferring its technology, the government enhances commercial firms' investment in developing better, cheaper technology solutions. The companies mature the technology and find commercial applications for it — marketing the technology and broadening its use. The technology can then become available, as developed commercial products, to the government at market prices for use in weapons systems. The National Technology Transfer Center (NTTC) teaches a course about commercializing government technologies.[2]

This type of partnering with industry is a long-term approach. For technology from government sources to grow and mature commercially, and then be used in a weapon system, is a process that can take years. The advantage to this approach, of course, is that industry provides the majority of the financial investment for development, and eventually a worldwide marketplace arises that can lead to future technology transitions. Starting some of these projects today so the technologies can be used in weapons systems in the future is important.

Developing dual-use technologies is another way to make government-funded technology available in commercial venues so the technology can be further developed. Developing dual-use technologies is a cost-effective way for government and industry to share in the benefits of developments.

Consult DoD Directive 5535.3, *DoD Domestic Technology Transfer (T2) Program*, May 21, 1999, for information on how to protect government IP rights to allow for licensing and leveraging of technologies.

How are you ensuring access to the latest technology from the small business community?

[2] For more information, visit the NTTC's Web site at http://www.nttc.edu/aboutnttc/newsdetail.asp?recnum+31.

Contract award data for FY2000 reveal that nearly $3 billion out of a total of $19.2 billion in DoD awards for R&D went to small businesses. These R&D awards account for 16 percent of the total DoD contract awards for small businesses. About 75 percent of the R&D awards to small business were for work on S&T — budget account categories 6.1, basic research; 6.2, applied research; and 6.3, advanced technology development. The remaining 25 percent of the small business R&D awards were for demonstration and development (categories 6.4 through 6.7). PMs should engage the small business community to ensure that the government has access to the results of this R&D.

Further, because much technology innovation originates in non-traditional firms (those firms that do little business with DoD),[3] a significant amount of R&D money should go to the prime and subcontractor businesses. When selecting the contractors for S&T contracts, source selection committees should review the contractors' plans for integrating large and small non-traditional firms, and should award contracts to prime contractors that are making the best use of these technology resources.

S&T and T&E Communities

Have you formed a T&E working-level IPT to assist in planning and integrating T&E early?

Forming a T&E IPT early, in the pre-systems acquisition activity for programs that probably will result in an acquisition program, can be very useful for fully integrating continuous T&E, which is needed for fast-moving programs. The contractor's and government's Developmental Test and Evaluation (DT&E); Operational Test and Evaluation (OT&E); and, if applicable, intelligence and Live Fire Test and Evaluation (LFT&E) personnel should be members of the IPT. These subject-matter experts are particularly critical if the program needs a combined DT&E, OT&E, or LFT&E approach.

Acquisition and Sustainment Communities

Are your program needs prioritized so the S&T and R&D communities can respond accordingly?

Let the S&T and R&D community, in both government and industry, know your needs and priorities. You should state your needs as problems to be solved, allowing the technology providers latitude to determine the best technology solution. Also, challenge technology providers to refresh technology alternatives and access commercial technology. Peer reviews are one practice that industry uses to "scrub" its technologies to winnow out unproductive programs.

Do you encourage continuous competition of technology providers, e.g., through an open continuous BAA, or by nominating SBIR topics?

Be on the lookout for ways to keep your prime contractors competitive in terms of technologies they are incorporating into weapons systems. The warfighters need the most effective weapons systems possible; however, technologies used in weapons systems are not always the best available.

Government technology managers need to remain open to technologies that disrupt current plans. These types of technologies push the state-of-the-art, sometimes by using an existing technology

[3] See Chapter 1 for a discussion of traditional and non-traditional defense contractors.

in a way that has never been used before. These types of technologies can revolutionize mission performance and often challenge the current line of scientific inquiry, established S&T programs, or the revenue base of the incumbent contractor.

You might keep the competition among technology providers alive through the use of BAAs, which identify challenges that need to be addressed by the technology community. The SBIR program is another way to seek out technology solutions in industry, where many solutions come from small businesses. Even if these technology solutions are different than the solution your prime contractor is proposing, you should direct the prime contractor to incorporate the best technology — if the technology is worth the risk.

Prime contractors should be required to submit a plan, as part of their proposal, describing how they will manage the competitive environment — that is, how they will create an environment to keep competition going at the subcontractor level and create competitive alternatives. Emphasis should be placed on the subcontracting plan, because being able to integrate new technologies throughout the program will depend on its success in stimulating the commercial technology base.

Another way to encourage access to the technology base in non-traditional businesses is by tying prime contractor incentives, such as award fees, to their use of non-traditional businesses as subcontractors.

Capability Needs and T&E Communities
Does the T&E Community participate in the capability needs development process?

The interface between the capability needs and T&E communities is important. The capabilities described in a needs document must be measurable, testable, and achievable. The S&T and R&D communities provide information to capability needs writers to assist them with establishing the required performance capabilities that are achievable. The T&E community can assist the needs writers with describing how these capabilities will be measured and tested. Properly describing required capabilities that are measurable, testable, and achievable is critical for developing the incremental capacities that are vital to the success of evolutionary acquisition.

Acquisition Community
Is your program designed to promote open standards so new technology can more readily be integrated?

To facilitate evolutionary acquisition, use modular open systems approaches to integrate the latest technologies and products for modernizing fielded assets affordably and supportably. Using commercial interface standards as much as possible is beneficial. These standards help ensure interoperability, portability, scalability, and technology insertion.

The benefits of the open systems approach include accelerating the transition from S&T and R&D to acquisition and deployment, using commercial investment in new technologies and products, and maintaining continued access to advanced technologies and products from multiple suppliers during all phases of the acquisition process. Other benefits are that the risks of technology obsolescence are mitigated, you are not locked into proprietary technology solutions, and you do not have to rely on a single source of supply during the life of a system.

The Defense Acquisition Guidebook (formerly 5000.2R) identifies the open systems approach as a best practice, integrated business and technical strategy for acquisition. An open systems approach enables you to more rapidly develop weapons systems with demonstrated technology and facilitate future upgrades without major redesigns during all phases of the acquisition process. Open systems also enable you to continue to evaluate advanced technologies for implementation and eliminate your dependence on an incumbent producer's proprietary technology and support. A secondary benefit of the approach is that you can more readily analyze the business case to justify decisions for enhancing life-cycle supportability and you can continuously improve product affordability through technology insertion during initial procurement, reprocurement, and post-production support. DUSD(S&T)'s April 2001 guide *Technology Transition for Affordability: A Guide for S&T Program Managers* is available from the Manufacturing Technology Information Analysis Center.

Are these open standards and interface specifications available to third parties for inserting technology?

Take steps to disseminate your interface specifications to S&T organizations, both in and out of government, that can develop or help identify technologies of interest. You can disseminate the information through "Industry Day" meetings and other forums. Further, establishing "form, fit, and function" specifications, based on performance-based capabilities, aids greatly in implementing alternative enhancements in the future.

Sustainment Community

Is your program designed to promote open standards so new technology can more readily be integrated?

For legacy systems, the traditional approach for acquiring spare parts has been to buy a "tech package" that is basically a list of parts and detailed design specifications. The problem with this approach is that it locks DoD into the same vintage of technology that was used in the original design. Furthermore, because the original vendor may not be available or may be using later technologies, staying with an older technology may cost more than changing to a newer one. However, transitioning older specifications to performance-based specifications has been somewhat successful. This approach gives contractors more opportunity to integrate new technology. To make this process enticing, contract incentives may be needed.

Sustainment organizations need to work with the PM to identify subsystems or components that are candidates for technology updates; to change from using "build-to-print" parts and components to "form, fit, and function interface," where this makes sense; and to collaborate on issues of obsolescence. In some cases, replacing or refreshing technology may require re-qualifying and re-certifying systems, subsystems, parts or components — particularly where they are flight-critical or critical safety components.

Issue 1-B: Identifying and Selecting Available Technology

Identifying and selecting technologies are important early steps in developing or upgrading weapon systems. Technology "clearinghouses" (e.g., Tech Connect,[4] Technology Information

[4] http://www.afrl.af.mil/techconn/index.htm.

Clearinghouse,[5] Air Force collaborator project, and Virtual Technology Expo[6]) exist for identifying technologies. Often PMs rely on prime contractors to identify and select technologies to insert into systems, believing the contractor will always use the best source for technology, and use it to develop the system. However, this is not always the case and may not be the best way to find leading technologies that are applicable to weapons systems. Working together, the communities for capability needs, S&T, R&D, T&E, acquisition, and sustainment, must work hard to communicate program requirements and identify the technologies, regardless of their source, that most benefit the warfighters.

CONSIDERATIONS

Capability Needs Community

Do you want opportunities to educate technology providers and acquisition personnel about future warfighting concepts and anticipated new capability needs?

Technology providers and acquisition professionals offer the best support when they understand the underlying warfighting concepts and environment. Some of these professionals understand a great deal about the warfighting environment, and some do not. Consider using briefings to inform S&T, R&D, and acquisition personnel about future warfighting concepts, or to demonstrate existing warfighting systems that show the context in which the new system will perform. In addition to educating, these sessions build relationships and communication, enabling an integrated assessment of trade-offs when systems are being developed.

Did you seek information about available technologies from industry and government sources before developing the capability needs document?

An understanding of the available and future technologies will improve the capability needs document in two ways. First, such an understanding will ensure that requirements are achievable and affordable. Second, the understanding will ensure that capability needs writers consider innovative options available for meeting the required capabilities and avoid unnecessary constraints that might limit options. Without knowing the current possible technologies, the writers could over- or understate the need. If the needs are overstated, PMs might spend more time and money in development than is necessary. If the needs are understated, the warfighter loses capabilities to support the mission. For example, a technology provider may have more than one solution in mind and PMs may be tracking two separate technologies. One may require low investment, and have low risk and low payoff. Another may be higher risk, require a higher investment, but have a much greater payoff. If the capability needs document has sufficient flexibility, the PM can maximize results in a managed-risk environment.

Is the capability needs document written in terms that allow the developer the maximum flexibility in meeting the warfighter's need?

Sometimes capability needs are written in a way that limits the developer's solution. By focusing on the needed capabilities, rather than trying to describe a specific system in the needs document, the developer can allow technology providers to propose innovative solutions for providing the capabilities.

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[5] The Air Force Research Laboratory's Technology Information Clearinghouse can be accessed by calling 1-800-203-6451 or online at http://www.afrl.af.mil/techconn/index.htm

[6] The Virtual Technology Expo can be accessed online at https://vte.dtic.mil. See Appendix B for more information.

S&T Community

Do you have a process that maps technologies you are developing to weapons systems requirements?

Although not all S&T investments are directly aligned with future weapons systems, S&T leaders (whether government or industry) must maintain close and continuous ties with the warfighters or other users of systems, as well as with acquisition and sustainment PMs. Maintaining these ties can help ensure that S&T leaders understand the needs, develop technologies that will be useful for satisfying those needs, have a sense for the timing needed for integration, and anticipate future warfighting needs. The ties can be maintained through formal forums or, even more effectively, through frequent interactions between technologists and acquisition or sustainment PMs. The interaction will help keep S&T projects focused on increasing the effectiveness of a mission capability while decreasing cost, increasing operational life, and incrementally improving products through planned product upgrades.

S&T leaders must ensure that information about technology development programs is continually available. S&T technology developers can publicize information about technologies they are pursuing through the following:

- Web sites and publications;
- meetings, briefings, and other forums; and
- partnering directly with program offices.

S&T leaders should also assign some of their best people to become "application brokers" to link technology programs to developments in weapons systems to ensure the technology they are developing will be used in the systems. When the leaders use application brokers, they will find that acquisition and sustainment PMs may be willing to invest in, and apply, the technologies that most directly benefit their programs.

Do you have a process that identifies potential commercial technology for satisfying acquisition program needs within planned timeframes?

Government S&T should interact with industry to identify commercial technology. Because no single place or method is best for finding commercial technology, someone in the S&T organization may have to spend some effort, maybe full time, investigating commercial technology. Appendix B lists resources for locating technology. Despite the variety of available resources, attracting non-traditional contractors to work with government organizations is often difficult. You may need to work with contractors who do not normally do business with the government. Contractors should be evaluated on the basis of their performance in commercial markets and the capabilities of their technologies. To evaluate the contractors well may involve personal contact and discussions about how projects will be mutually beneficial.

Using commercial technologies that have been successfully tested for, and integrated in, a military environment is the preferred way of doing business. However, commercial technologies may have to be modified for military use.

Acquisition and R&D Communities
Do you have effective approaches for identifying and inserting both incremental and radical technologies into your program?

Priority consideration should be given to the most cost-effective solution over the system's life cycle. In general, decision makers should first consider the procurement of commercially available technologies, or the development of dual-use technologies, to satisfy user needs. Developers must work with system users to modify requirements, whenever feasible, to facilitate such procurements. To do what is required, consider assigning "S&T liaisons," whose prime mission is sharing the program's needs and identifying technology available from all sources. A secondary mission for liaisons is gaining funding and other support for maturing or transitioning technology and for dual-use technology work from labs and other organizations that have budgets for this purpose. Give preference to modifying an existing commercial-off-the-shelf item to meet the need, especially if the warfighters benefit in the long term. You need to be aware of the "not-invented-here syndrome," which often impedes selecting and using the best, most cost-effective technologies. In many instances, relevant commercial (and sometimes government) technologies are being developed that can be used in weapons systems. The challenge is to find and adapt them.

Consider implementing a Process Improvement Team (PIT) concept in which acquisition workforce specialists (including technologists) are involved in the development of warfighting requirements. This will ensure that the art-of-the-possible in technology is understood by the warfighter, and that the technology and acquisition communities understand the warfighter's needs.

Market research is an integral part of the process. It includes surveying market literature and news, searching the Internet, and working with other departments, government agencies, and industry contacts. Marketers should look at the technology offerings, gain an understanding about the credentials of the firms (e.g., past performance and financial health), the terms and conditions for contracts prevalent in that industry sector, IP, pricing, and warranties. This understanding can help later in constructing the business case for implementing such capabilities, as well as in selecting the best contracting vehicle, such as OTs or FAR Part 12 contracts or subcontracts, to establish a business relationship with these non-traditional commercial suppliers. These contract vehicles will be especially effective with non-traditional businesses that are unwilling or unlikely to be able to afford to comply with stringent DoD business requirements, such as Cost Accounting Standards (CAS) and Truth In Negotiations Act (TINA) requirements.

Acquisition, R&D, and Sustainment Communities
Have you researched other programs in the government (DoD, NASA, etc.) for technologies that could be transitioned into your program?

Other programs or DoD agencies could be developing technologies that may be very useful. Currently, there is no institutionalized way of easily finding the technologies. However, you can search for technologies in several places, such as the Web sites of S&T organizations or other programs, the Defense S&T Plan, as well as the sources (such as Tech Connect[7]) listed in Appendix B. An excellent place to begin the search is the Acquisition, Technology and Logistics (AT&L) Knowledge Sharing System (AKSS) at http://akss.dau.mil. Our list is not all-inclusive,

[7] http://www.afrl.af.mil/techconn/index.htm.

however; one of the best ways to access these programs is still through personal contacts, often made at a technology conference or academic forum. The Defense Acquisition University sponsors technology transition conferences on a periodic basis. Check the DAU Web site at http://www.dau.mil for the latest information on upcoming conferences. One thing to consider is whether your program needs are similar to those of another program in your Service or another Service. If this is the case, a technology insertion plan may exist that could help you identify applicable technologies and their sources. Using technology developed in another program may be the most efficient way to reduce costs, gain a technology solution that fits the program, and improve supportability.

Do you require a business case analysis for selecting and inserting the best technology, regardless of source?

For assessing commercial technology, you begin by surveying experts in the field to determine the technology options that will be available. After the survey is finished, you can evaluate the investment options for maturing the commercial technology to satisfy the warfighter's need. (A similar model can be instituted for military technologies.) Market research and analysis will help determine the availability, suitability, operational supportability, interoperability, and ease of integration of existing commercial technologies and products and non-developmental items.

One way of assessing technology trade-offs is with simulation tools. Although simulation tools can help with evaluating a technology technically, the tools do not address myriad business-related issues. For example, competitive technologies, logistics support and training issues, scheduling issues (e.g., those having a ripple effect), and budget changes might complicate the evaluation.

Analyzing the business case for a technology investment includes more than evaluating the finances. The analysis includes numerous considerations, the careful evaluation of which could lead to unintended and unexpected consequences. For example, you should consider the following:

- Is the system that will receive the technology still being developed or is it already fielded?
- Is the technological opportunity evolutionary or revolutionary?
- What is the maturity level (i.e., the TRL/EMRL) of the item? How will risk be managed?
- Is the source of the new technology external or in house?
- Will the new technology require changes to, or revisions in, logistics support infrastructure, training, documentation, schedule, or current or future budgets?
- What funding sources will be required for technology insertion or support, and is funding available?

- Do expected benefits include improved performance capability, lower acquisition cost, or lower operations and support costs? Can the expected benefits be reasonably defined and quantified?

- Does inserting technology require other investments or costs? Can the costs be reasonably defined and quantified? Are existing budgets capable of sustaining the required costs?

- Could competitive technologies overtake this opportunity?

What processes exist for identifying state-of-the-art commercial technology that will improve maintainability, affordability, and system performance?

Such processes generally tend to be ad hoc. The Office of Naval Research (ONR) hosts an S&T industry conference each year; the Army hosts Industry Days, and so on. Be aggressive in nurturing communications with appropriate organizations that might contribute to harnessing key technologies. For example, in working with government labs, ask them about their outreach to the commercial sector to be sure they are exploiting the potential of the latest commercial technologies.

Often the commercial sector is developing technology that would meet military needs but is hesitant to do business with the government, while the government may be wary of new companies entering defense markets. DARPA attracts private-sector developers because of its flexibility in contracting as well as its approach to IP rights, and the agency is attempting to learn how to involve industry to a greater degree in transitioning products into acquisition programs. You should consult with DARPA when you are trying to find commercial solutions. Many of the solutions available to DARPA (e.g., OT authority for prototype projects) also are available to other agencies.

Issue 1-C: Accessing and Using DoD Technology Development and Transition Programs
Many government programs encourage developing and enhancing high-technology solutions to meet the challenges faced by weapons systems development and sustainment programs. However, PMs often do not effectively use these programs, either because they are unaware of them or because they have not institutionalized an approach for using them to develop technology solutions.

CONSIDERATIONS
All Communities
How are you staying abreast of available programs, and what are you doing to access their resources?

Assign someone in your organization to work not only as a liaison, but to aggressively work SBIR, ManTech, and other programs for the PM. That person should review applicable programs and come up with strategies for accessing their resources. Network with those who have successfully accessed these programs, and be sure proposals are thoughtfully developed and adequately address the criteria against which funding will be granted.

Several government initiatives are focused on helping small businesses gain access to the government market. One example is the Missile Defense Agency's Technology Applications Review. This review is conducted by a "board of directors" consisting of business executives from large companies, such as Boeing, that assist small companies with their business plans. Through this process, small and large companies form business relationships that eventually help deliver better systems to the government.

To access technology in commercial non-traditional laboratories, a good first step is to determine which laboratories have a track record in the technologies that can be precursors to those of interest. Then, determine whether their laboratories have technical personnel who are recognized leaders in the field, a corporate reputation in the technology, related equipment available, and/or a number of related patents and technical papers.

If a program needs advanced revolutionary technology that may have significant commercial potential, then very likely the only way to identity potential sources is to find firms that have funding from a university or non-profit laboratory doing work in precursor technologies that have been hiring their graduates. Many of the non-traditional businesses that are funding these developments do so in order to have a leading-edge product for which they will be the exclusive source for a number of years.

Acquisition, R&D, and Sustainment Communities
Are you providing technology topics to the SBIR program?

The SBIR program, which is funded by a tax against the DoD R&D budget, helps small businesses develop technology capabilities. The funding of technology through the SBIR program is relatively easy and streamlined. To participate, program offices submit topics for technology development to small businesses through the SBIR program and may solicit applicable topics from prime contractors. You might find that developing technologies through the SBIR program provides alternatives to the technologies that prime contractors propose using in weapons systems. Any competitive tension from your pursuit of SBIR alternatives may encourage your prime contractors to work harder to find the best technologies for the systems they are developing. Program managers should seek ways to set incentives for transitioning technology and using non-traditional technology sources in award fee guidelines.

Are you submitting high-quality proposals for defense-funded programs (e.g., ManTech, WRAP, and reduction of Total Ownership Costs (TOCs))?

As can be seen in Figure 4-1, these programs are available for the entire life of a product.

These programs help the S&T community — both contractor and government — transition technologies to programs. The contractors and the government have somewhat different strategies or processes, but DoD has designed each strategy or process to emphasize transitioning technology and address problems such as lack of transition funds, definition, visibility, and priorities toward transition; and for which the S&T, acquisition, or sustainment community has differing goals and timelines. The strategies involve teaming between the communities and are focused on learning more about technologies in systems, as well as improving affordability and rapid transitions to systems. You can benefit from learning more about these programs and using them to your advantage.

Are you familiar with the timing and other requirements of budgets?

To access programs that provide funding, you must comply with the requirements of the budgetary process in your Service or agency. Compliance will probably require submitting certain documents by specific dates. If you do not or cannot comply, you may not be able to secure funding. Become familiar with the relevant parts of the budget process, perhaps by asking for assistance from the personnel in your Service or agency who deal with RDT&E funding.

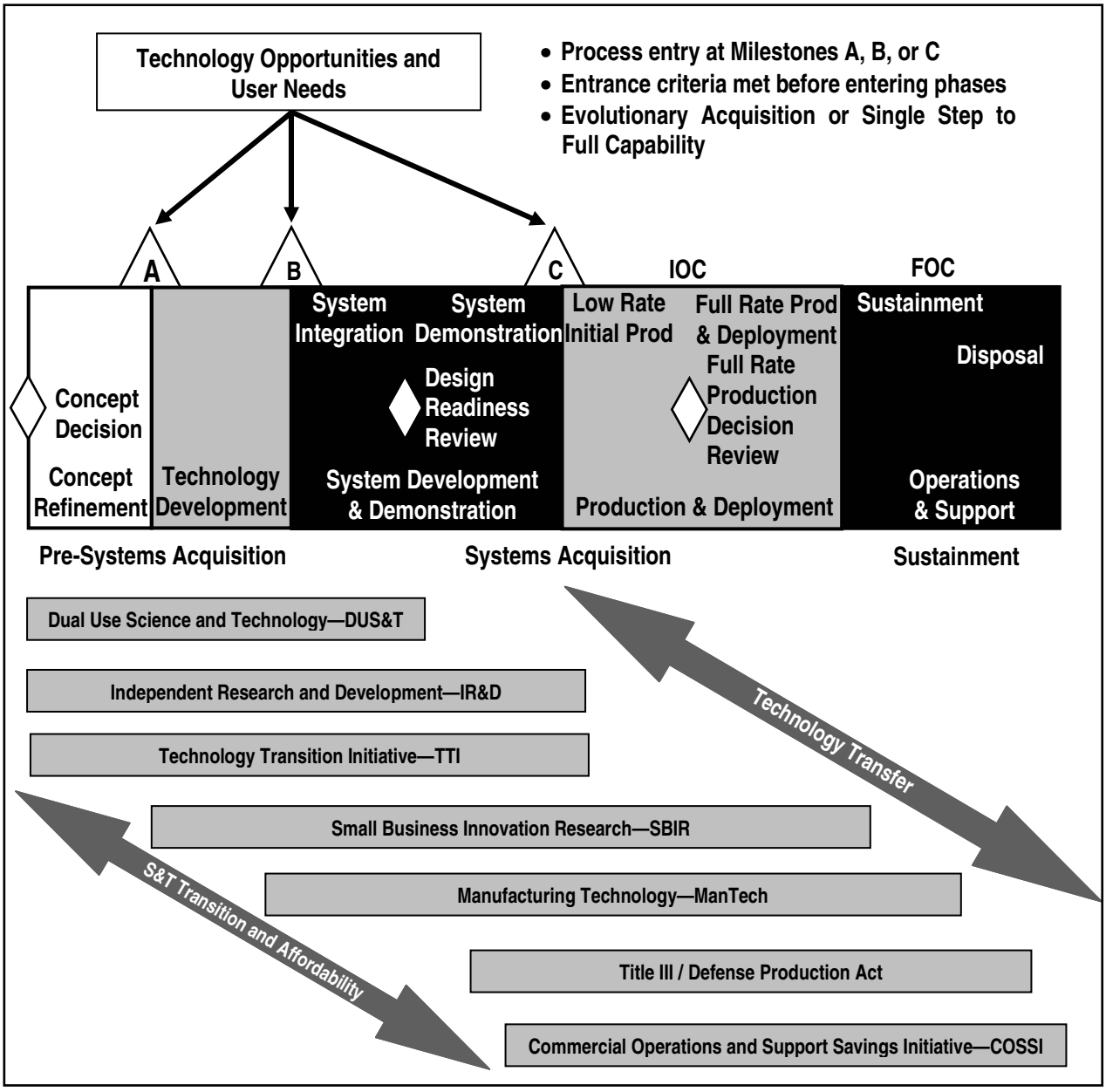

Figure 4-1. Support for the Product or Process Life Cycle

Issue 1-D: Planning for Transitioning Technology

If you are using an evolutionary approach vice a single-step approach to developing weapons systems, breaking up the program into increments of militarily useful capability is critical.

Increment 1, for instance, would be the initial deployment capability, and other increments would follow in the order in which the system is developed. The PM must describe in the acquisition strategy how the program will be funded, developed, tested, produced, and supported. The description should include the plan for technology insertion, and the PM should have a weapons system support strategy that addresses how the PM and other responsible organizations will maintain appropriate oversight of the fielded system. Oversight shall identify and properly address performance, readiness, ownership cost, and support issues, and shall include post-deployment evaluation to support planning for assuring sustainment and implementing technology insertion to continually improve product affordability. Probably the best way to begin is to establish an IPT that can work its way through these issues.

Planning early to insert technology continually is crucial to acquisition program success. The rapid and effective transition of technology from the science and technology base to weapon systems is a process that requires the S&T community to understand and respond to the time-phased needs of the warfighters. Because the process requires the acquisition community to plan for the initial system capability and to incrementally introduce new technology, the acquisition community must thoroughly understand the technology's readiness for transition.

CONSIDERATIONS

Capability Needs Community

Does the capability needs document support evolutionary acquisition in an incremental fashion?

Two basic approaches are used for writing capability needs documents that support evolutionary acquisition. In the first approach, Incremental Development, the ultimate functionality can be defined at the beginning of the program, and the content of each phase clearly delineated in the requisite capability needs document. In all cases, the capability needs community needs to know the capability shortfall in advance and articulate it in the needs document. In the second approach, Spiral Development, the ultimate functionality cannot be defined at the beginning of the program, and each increment of capability is defined according to the maturation of the technologies matched with the evolving needs of the user. This is new territory for most capability needs writers and will require coordinating closely with the acquisition community.

Regardless of the approach, when an increment of capability is defined, the threshold performance parameters, or "exit criteria," must be well delineated for each increment. The delineation is necessary for a number of reasons. For one, it ensures that the users clearly understand what will be provided. The criteria used to define the initial increments are needed by the testing community so the system can pass developmental and operational tests for an individual increment without meeting the full requirements of the capability needs document. An evolutionary capability needs structure is fast becoming the rule rather than the exception.

The capability increments cannot be immutable. Capability needs must be flexible enough to enable change as users increase the knowledge and understanding of system capabilities (e.g., from experience with the first increment systems), as the threat changes, and as technology changes. This is the true value-added of the Spiral Development method.

S&T Community

Do you plan for product maturation and integration?

Industry is the prime recipient of government-developed S&T. Therefore, you must work with industry to ensure your S&T is sufficiently mature and integration is planned early in the process. Providing industry with adequate information about technology developments is important so contractors can integrate the technology into weapons systems.

Do affordability metrics, a transition strategy, and exit criteria exist for transition?

Although the technical merits of a technology may be critical for satisfying warfighter needs from a performance perspective, other aspects are important. For example, the technology must be affordable. Early consideration of the life cycle cost of a technology will increase the probability that it will be used in the system. Furthermore, planning for transition is vital to specific programs. Working with potential downstream PMs early will improve the likelihood of their acceptance of a program. They naturally will want to understand the exit criteria you plan to use in determining if the technology is ready for transition.

Do you have a budget and plan for contingencies to prevent the technology "valley of death," i.e., a hiatus in funding when funding shifts from 6.3 to 6.4?

The PM community often has a difficult time synchronizing the technology transition funding. The PPBE process requires a nominal two-year lead-time for funding to be approved. As a result, accommodating fast-changing S&T developments in acquisition programs can be a challenge. The PM community cannot always predict the pace of innovation two years in advance, and funding may not be available for fast-moving S&T projects that are ready for transition. Therefore, a desirable S&T project may stall for 18 to 24 months awaiting funding. This gap is sometimes called the "valley of death."

Some flexibility in the funding process can be exploited. Sometimes changes, especially small changes, can be made in budgets as they are being finalized. Budgets are finalized in the fall of each year, about a year before funds become available. Once funds become available, and are being spent or executed, changes can be made through reprogramming. Potential reprogramming changes are usually assessed by Services and agencies in the early spring of each year, although small changes can be considered at other times. In most cases, to qualify for reprogramming changes must be unexpected, and increases must be offset by reductions in other programs.

To take advantage of available flexibility in the budgetary process, you need to learn the dates and other requirements imposed by your Service or agency. You can get this information by contacting the personnel in your financial community who deal with RDT&E funding. You also can minimize the chances of funding gaps by identifying and working with potential downstream PMs early in the process to plan for the necessary transition funding (often from 6.3- to 6.4-type funding). If a PM will sponsor your request, you will more likely be successful in exploiting available flexibility in the budgetary process.

If you do encounter serious problems with the constraints of the budgetary process, consider documenting the problems and making them available to personnel in your financial community. DoD often has asked Congress to make funding more flexible. These requests have sometimes been denied for lack of specific, documented problems. You can help in the quest for financial flexibility by documenting problems.

Do you have strategies for inserting new government-developed technologies into prime contractors' weapons systems?

In the past, defense programs were largely responsible for determining what technology was used. Today, prime contractors have a much greater role because they function more as prime integrators. Further, they tend to use performance-based specifications and have more latitude in their solutions. Therefore, when a government lab develops an innovative technology not available in the commercial marketplace, it must take on the responsibility to ensure that the technology is "packaged" so industry can use it when appropriate.

Acquisition, R&D, and Sustainment Communities

Do you have a plan for inserting technology?

A plan for inserting technology should describe the technology enhancements that will be made to a weapons system and when they will occur during the acquisition process. Such a plan would include strict exit criteria, and TRLs and EMRLs would be used to evaluate the transition between the S&T community and the acquisition community, as well as provisions for funding. The process is similar to that employed by users when they establish performance-based capability needs.

Program offices should have a plan for their system, going out at least the length of the Future Years Defense Plan (FYDP)[8] or longer, showing major planned improvements and other points where technology will be inserted. Furthermore, PMs should coordinate with other PMs for similar systems, with Services that have similar systems, or with the PEO about his or her portfolio to look at opportunities for using multi-platform joint development programs. Having this clear picture and sharing it with the warfighters, requirements staff, S&T groups, finance and budget people, industry partners, and logistics staff will ensure that inserting technology is better coordinated and reduce chances of a hiatus in funding.

For fielded systems, what processes exist for making resource decisions, including funding for the testing of improvements to maintainability, affordability, and system performance?

Different programs will require different solutions for inserting post-fielding technology. You should investigate the availability of funds and programs in your Service for inserting technology. The prime contractor for sustainment should have incentives in the contract for inserting technology.

Do you have a tailored strategy for inserting technology continually, given the overall acquisition strategy (e.g., prime contractor, system integration contractor, and total system performance contractor), and for considering planned incremental timeframes?

Once programs are approved and a baseline for cost, schedule, and performance is established, PMs can be reluctant to investigate technology that could add risk to a program. This approved program can be a powerful disincentive for inserting technology. Instead, PMs should be rewarded and recognized for investigating new technologies and managing the attendant risk.

[8] The FYDP is a database maintained by the OSD that holds data on all approved programs for the Department. The FYDP contains resource and force structure information for the prior year, current year, two budget years, and the following four "outyears."

Do you use effective methods to transition lab technology into prime contractor solutions?

You need to be asking your technology providers how they plan to integrate their technology into prime contractor solutions. Building a relationship and trust with your providers is a start toward transitioning technology successfully. Further, you might find that the providers have collaborative agreements for enhancing such a transition. Similarly, a focus on the prime contractors may be necessary for a partnership to be successful.

Will candidate commercial technologies be there when your program needs them? If not, what measures are you taking to ensure that evolving commercial technologies are integrated into your system?

Moore's law says that computing power doubles every 18 months. Other technologies have similar benchmarks. Technology growth is exponential, and this has been causing problems for our linear acquisition strategies.

If your program is being developed using defense-unique technologies, obsolescence is the problem that is most likely to be encountered in the sustainment phase. Because technology cycle times are decreasing and the demand from the commercial market is driving much of our technology, your program must be designed to keep pace with the rapid cycle of the commercial market. No matter whether your system uses defense-unique technology or commercially available technology — particularly in the electronics and computer components that are pervasive in many weapons systems — changes and obsolescence will be continual. The way to deal with these changes and obsolescence is to design for them, plan for, budget for, and have technology refreshment programs in place so improvements in both capability and affordability can be incorporated throughout the useful life of the system. Last-time or lifetime buys are not normally very efficient. Good parts-management tools are available with predictive capabilities that your program office or prime contractor should be using for managing the supply chain and sustaining the system. In some cases, you will periodically need to fund re-qualification and re-certification testing.

Issue 1-E: Teaming and Partnering

The key to identifying acquisition strategies early and planning technology solutions is teaming among government S&T organizations, contractor development groups, and the program office. You must create an environment that engenders the commitment of all players and their trust in the process.

CONSIDERATIONS

All Communities

Do you participate in teaming or partnering with relevant programs for technology transition?

Once technologies that are applicable to an acquisition program are identified, teaming or partnering between the technologists and the weapons systems developers creates a relationship in which the technologists become key members of the team and have a vested interest in developing the system.

Too often the technology organizations pursue programs that have no direct application to meeting warfighter needs. Similarly, programs may pursue development opportunities that are inconsistent with a laboratory's technology initiatives. Communication and partnering among the

S&T, capability needs, acquisition, and R&D communities must be continual to ensure the right technology gets to the warfighter rapidly.

Acquisition, R&D, and Sustainment Communities
Do you participate in a transition agreement with the involved communities?

A negotiated business agreement among the involved communities is a means for transitioning technology from the S&T community to the acquisition program by fostering common objectives for the program. The agreement should include plans for executing the project and for the technology demonstration milestones, transition targets, and schedules. The existence of an agreement helps ensure that each party understands expectations because the agreement must define standards of transition success clearly, and acknowledge that success when developing technology is never guaranteed, despite the best efforts of those involved. The agreement should commit the S&T community to diligence in developing technology, and the PM to supporting the technology and transitioning it to the acquisition program if it proves successful. Early commitment from the warfighter is equally important. Some agreements are structured such that the warfighter agrees to use technology as a mission need; the technologist agrees to develop the technology according to a planned milestone schedule; and if milestones are met, the acquisition community agrees to budget and plan for introducing and integrating the technology into the program. To accommodate the occasional failure in some technologies, contingency plans should be considered for substituting alternative mature technologies. Agreements should be signed by each party, and management should use the agreements to follow up and control the project. Resources should be allocated on the basis of these agreements.

Issue 1-F: Making Technology Ready
While technology is being developed, its readiness for insertion into current technology must continually be evaluated. You need a systematic process for measuring that enables you to determine the maturity of specific technologies and compare different types of technology.

CONSIDERATIONS
All Communities
Do you consider technology maturity when assessing technology?

Many programs have found that using Technology Readiness Levels (TRLs) is beneficial for assessing technologies. TRLs provide a systematic measurement system for assessing the maturity of a technology and for consistently comparing maturity of different types of technology. NASA has used TRLs for many years for planning its space technology, and, as described in the *Interim Defense Acquisition Guidebook*, the use of TRLs is a "Best Practice" for all new DoD programs. Furthermore, component S&T executives are required to assess technology readiness for critical technologies identified in Acquisition Category (ACAT) ID (Major Defense Acquisition Programs where the USD(AT&L) is the Milestone Decision Authority) and ACAT IAM (Major Automated Information Systems) programs before Milestones B and C. PMs in other programs will also find that using TRLs is beneficial for assessing technology maturity because the definitions of the TRLs can be tailored to specific programs. In many cases, augmenting (not changing) TRL criteria is helpful for making them more useful for your own program.

What method do you use for considering engineering, manufacturing, producibility, interoperability, and integration when you assess technology?

The IPPD method is an excellent top-level method for ensuring that engineering, manufacturing, producibility, interoperability, and integration considerations are addressed up front.

Although the TRL approach is a valuable tool for assessing the maturity of technology, this approach, as currently applied, does not adequately assess the readiness of a technology for production. The Missile Defense Agency (MDA) is using Engineering Manufacturing Readiness Levels (EMRLs) to assist with evaluating the maturity of their technologies.

Acquisition, R&D, T&E, and Sustainment Communities
Are you using the IPPD process and do you review product maturation, producibility, and integration with the technology provider to reach desired readiness levels and mature technologies?

If you can engage with a government technology developer or commercial company about their plan for advanced or next-generation technologies, request they assess technology in the context of the TRL review. If technologies are not proceeding as planned, reassessing their viability may lead to pursuing alternatives. In addition, assessing integration readiness levels is particularly important because of the general reliance on commercial technology for upgrading software.

Issue 1-G: Reducing Risk
No matter how well a technology's development is proceeding, the possibility always exists that it will not be totally successful in producing the solution needed by weapon system acquisition programs. Even if solutions become available, they may not be available in time. Therefore, some forethought is required to identify alternative approaches to ensure the program will meet its objectives.

CONSIDERATIONS
Acquisition, R&D, and Sustainment Communities
Do you plan for mitigating risks for technology failures and funding shortfalls?

You may want to define Critical Success Factors (CSFs) — critical management activities that define an acceptable deliverable or series of deliverables for a technology solution. CSFs are activities that can be tracked and measured and are based on performance. CSFs are used in addition to the detailed project plan and other project documentation. Using CSFs requires not only identifying the factors and their appropriate measurements, but also analyzing the underlying constraints. The analysis will help you devise ways to manage risk in case technology providers are unable to deliver the technology when needed.

Another key activity in mitigating risk is to constantly explore alternatives for meeting the technology requirement. The SBIR program, in particular, is a good base of technology alternatives. Some PMs or PEOs are very aggressive and quite successful in using this program for developing alternatives to the incumbent technological approach, especially if progress is slow and milestones are missed. Competition can be an excellent motivator to the technology provider.

Issue 1-H: Changing Contractual Relationships

Accessing advanced technology from commercial sources may require using innovative contractual arrangements. You must use a new approach when trying to attract commercial sources, especially among contractor communities that typically do not work with DoD. Some companies stay away from government business because they do not want to go through the typical acquisition process, which takes time and investment and sometimes compromises their IP rights. Alternative contracting approaches are available, and you should consider them when trying to access the best technology for warfighters. The PM largely controls the acquisition strategy, and can facilitate and be an advocate for alternative contracting approaches.

CONSIDERATIONS

Acquisition, R&D, and Sustainment Communities

Are you using FAR Part 12 for modified commercial items?

Commercial item acquisition procedures that are based on FAR Part 12 are more friendly to non-traditional firms than are normal FAR contracts. The FAR Part 12 procedures are applicable to "minor modifications" to commercial items and "modifications of a type customarily available in the commercial marketplace." In some cases, FAR Part 12 can be used for a contract with a non-traditional firm even if the item must be modified. FAR Part 12 also can be used by prime contractors to contract with their suppliers.

Are you using Other Transactions (OTs) for prototype projects when traditional contracts do not attract sufficient commercial industry involvement?

When a commercial technology becomes available from a non-traditional defense firm that will not consider a FAR-based contract, OTs for prototype projects can be used. This type of agreement is flexible, especially for IP rights — which often inhibit these firms from doing business with DoD. When pursuing OTs for prototype projects, it is vital to plan early for the protections needed to enable the long-term support of an item once it is fielded. Because technical data, computer software, and patent rights may not be part of the contract, other approaches are necessary. For example, long-term support agreements and escrow agreements can be used. Refer to the DUSD(AT&L) Guide *Intellectual Property: Navigating Through Commercial Waters* [9] for further discussion.

Do the prime contractors share in the savings (or accrue other benefits) for bringing in new cost-reduction technology?

Prime contractors can be motivated to develop cost-reduction technology through programs that will provide a monetary incentive for innovation. Examples are a Value Engineering or similar shared-savings program, award-fee contract incentives tied directly to the fault-tolerance of the prime technology initiatives, and some protection of revenue base if a disruptive technology interferes with the prime business base.

Have you used share-in-savings strategies, such as VE? Has a proper cost-savings baseline been established?

According to FAR 48.101, VE is the formal technique by which contractors may:

[9] A link to this document is available at http://www.acq.osd.mil/dpap/.

- voluntarily suggest methods for working more economically and share in resulting savings, or

- be required to establish a program for identifying and submitting to the government methods for working more economically. VE attempts to eliminate anything that increases the costs of acquisition, operation, or support — without impairing essential functions or characteristics.

VE can be an effective technique for reducing costs, increasing reliability and productivity, improving quality, and avoiding procuring of obsolete parts. It can be used for developing hardware and software, as well as producing and manufacturing. It may be introduced successfully at any point in the life cycle of products, systems, or procedures. VE is a technique for analyzing the functions of an item or process to determine best value, the best relationship between worth and cost. In other words, best value is represented by an item or process that consistently performs the required function and has the lowest total cost. VE could yield a large ROI and has long been recognized as an effective technique for lowering the government's cost while maintaining necessary quality levels.

VE is a management tool that can be used alone or with other management techniques and methods to improve operations and reduce costs. For example, you might use VE and other cost-cutting techniques, such as life-cycle costing, concurrent engineering, and design-to-cost approaches, as analytical tools when developing processes and products. The complementary relationship between VE and other management techniques increases the likelihood that overall management objectives of streamlining operations, improving quality, and reducing costs will be achieved.

VE can be beneficial when the costs of weapons systems increase, forcing the program office to reduce quantities. VE can enable the government to fulfill inventory requirements, thereby benefiting both the government and the contractor in the long run. It promotes a cooperative teaming environment because government and contractor organizations often form process action teams with people who analyze and brainstorm new solutions and ways to reduce costs. In addition, VE enables sharing the cost savings with the contractor. You should offer incentives to contractors for developing and implementing VE cost-reduction proposals. These incentives should account for and offset the contractors' reduced profits as costs are decreased.

Have you balanced prime system contractor or integrator interests with program interests in promoting technology insertion?

Once a contract is established for a traditional development program, the prime contractor often is not motivated to bring in new technology if it would increase the cost, technical risk, or schedule risk of the program. However, evolutionary acquisition and spiral development offer the opportunity to introduce new technology in one of the next increments, especially if an open systems approach has been used. The next opportunity for such an introduction is during production, using a type of Pre-Planned Product Improvement (P3I) or an incremental upgrade approach. A parallel development, demonstration, and validation activity could be planned so as not to disrupt either the basic development or production contracts, with the new technology being introduced once the risk had been reduced sufficiently. Although an award fee might be used as an incentive for introducing new technology, DoD's profit-weighted guidelines include a

significant added benefit if new technology is shown to be incorporated in the contract being negotiated.

In the end, you must find ways to partner with the prime contractor you hold responsible for the performance and quality of the weapons system, as well as expectations for continued on-time delivery, reductions in cost, and improvements in supportability. Likewise, the prime contractor is responsible during sustainment for availability, spares, repairs, and for incorporating desired changes to improve capabilities as well as changes that are needed because of safety, obsolescence, or other factors. New technology can be a way to extend the life of a product, enhance its value to the user and, therefore, extend the production or increase the profitability of the item to the prime contractor and his or her entire supply chain. These are the "natural" economic factors that PMs can use in their dealings with prime contractors to balance risk and reward for all parties.

Issue 1-I: Protecting Intellectual Property

In the past, the government was the major impetus for R&D. Now, technologies shaping the economy are funded mostly by private industry, and we must foster an environment in which industry is willing to share its commercially generated technologies.[10] IP, which includes patents, copyrights, trademarks, and trade secrets, is intangible property that is critical to the financial well-being of a company. Because of the value of IP, companies, especially non-traditional businesses, want to ensure IP is protected before they do business with the government. Yet, you must consider long-term support and competitive strategies, early in the acquisition process, to protect core DoD interests. On the one hand, DoD's policy is to take minimum rights; and a recent policy letter specifically states, "Much of the intellectual property mindset culturally embedded in the acquisition, technology, logistics, and legal communities is now obsolete."[11] On the other hand, it is equally important that you identify strategies and outcomes that will protect DoD interests and IP, and ensure that contractors invest in core technologies and do business with DoD.

The larger leading commercial (non-traditional) firms ensure their continued existence and growth predominately by selling products and services they developed in the highly competitive global commercial market. Virtually every technology-rich commercial business aggressively protects its proprietary data. These data define the business and it's potential. These firms keep their proprietary data (especially data related to important commercial developments) well protected in the organization; usually it is as well protected as DoD protects its top secret information. Normally, only a relatively few trusted business and technical employees with a vested interest in the commercial success of the development will have access to the data.

In dealing with IP rights, the government has promulgated policies and regulations about patents, copyrights, technical data, and computer software. When acquiring IP license rights, the DoD acquisition community should consider certain core principles highlighted below.

1. Integrate IP considerations fully into acquisition strategies for advanced technologies to protect core DoD interests.

[10] USD(AT&L) Memorandum, December 21, 2001. Subject: "Intellectual Property."
[11] *Ibid*.

2. Respect and protect privately developed IP because it is a valuable form of intangible property that is critical to the financial strength of a business.

3. Resolve issues before awarding a contract by clearly identifying and distinguishing the IP deliverables from the license rights in those deliverables.

4. Negotiate specialized IP provisions whenever the customary deliverables or standard license rights do not adequately balance the interests of the contractor and the government.

5. Seek flexible and creative solutions to IP issues, focusing on acquiring only those deliverables and license rights necessary for meeting the acquisition strategy.

CONSIDERATIONS

R&D and S&T Communities

Do you have a strategy to protect a companies' technology that has been committed for implementing a program?

Government mishandling of companies' IP hurts DoD in the long run. Innovative firms will leave the DoD market or sell the Department only old technology. So, you should protect the IP rights of your contractors aggressively, thus establishing integrity and trust. For example, be sure that:

- non-disclosure agreements or disclosure limitation markings on documents are understood and adhered to;

- proprietary information is adequately protected (e.g., locked in a safe or file cabinet) and adequately controlled; and

- employees know that unauthorized disclosure could make them and the government subject to civil or criminal penalties.

In instances when funding for developing a technology comes from both government and industry, flexibility in achieving win-win IP terms is in order. Refer to the AT&L Guide *Intellectual Property: Navigating Through Commercial Waters*.[12] Above all, do not wait until later in the technology development cycle to address IP — the key is planning early.

Acquisition and Sustainment Communities

How does your acquisition strategy balance vital commercial IP interests?

You should not require IP rights in solicitations that will discourage non-traditional firms from doing business with DoD. If you automatically include unlimited or government-purpose rights because you believe the government is paying for the technology's development, you could cause some companies (with potentially vital technologies) to choose not to compete. If, on the other hand, your solicitations include provisions that show flexibility and a willingness to consider specially negotiated license rights, more commercial industry interest may develop. Researching the industry sector for the products or technologies you want will help determine

[12] The Guide is available online through a link at http://www.acq.osd.mil/dpap/.

what approach, role, and what IP rights the government wants to have and, furthermore, what licensing fees for such rights might typically be used in commercial practice. You should meet early with contracting officers, logisticians, data managers, and general counsel to discuss alternative strategies for creating a business environment that is conducive to accessing technology.

Is the acquisition strategy balanced with your open-system architecture IP needs?

Create alternative support strategies that use open systems only when interface data are necessary. By using form, fit, and function performance-based specifications, often all that is needed is the detailed design information for the key interfaces. DoD's long-term competitive interests can therefore be met through performance-based competition of the "boxes" between the interfaces.

How does your logistics support strategy fit with the IP environment?

If the system being developed relies heavily on commercial technology at the system, subsystem, or component level, the maintenance and support strategy you choose is very important. Many PMs are looking for "plug and play" maintenance concepts so detailed maintenance information is not necessary. Training information may be limited to performing the change-out. In addition, Contractor Logistics Support (CLS) from original equipment manufacturers or systems integrators is becoming a preferred method of support. Under these circumstances, if you are concerned about long-term protection from price increases because competition is reduced, you might consider third-party licensing agreements.

Issue 1-J: Controlling Exports

Commercial companies may be reluctant to sell to DoD, because DoD sales may restrict the future export of their technology. Controls on exporting technology discourage potential commercial technology solutions from entering defense markets. Export controls are considered excessively long and complex. Selling to DoD can introduce delays, uncertainties, and limitations that may inhibit the ability to export advanced products to worldwide commercial markets. Specifically, a firm with a dual-use technology may be reluctant to have its technology used in defense-related applications because of subsequent limitations to offshore production, the added costs of oversight by the Department of State (DoS) rather than the Department of Commerce (DoC), and possible restrictions on what capabilities can be offered in commercial markets.

Exports and access to foreign markets are critical to the success of firms selling high-technology products and services. These products and services may constitute commercial and dual-use technologies or defense items and services, including commercial satellites. The rapid obsolescence of high-technology items may affect the commercial success of an item adversely if the contract process delays access to the export market.

Basically, two control regimes exist, each administered by a different cabinet-level department of the executive branch. The DoC administers exports of most commercial and dual-use technology under the Export Administration Act (EAA)[13] and its implementing regulations. The DoS administers another parallel environment (munitions export licenses) for goods, services, and

[13] EAA, 15 C.F.R. 379.

software that are either critical to the military or are a part of a multilateral control of missile technology. In general, the DoS's actions are covered by the Arms Export Control Act (AECA)[14] and the International Traffic in Arms Regulations (ITAR).[15] Although DoD does not have a direct statutory or regulatory role in controlling exports, it nevertheless does affect exports.

Another law, the Invention Secrecy Act of 1951,[16] requires the government to impose "secrecy orders" on certain patent applications whose disclosure would be detrimental to national security. A secrecy order restricts disclosing an invention by withholding the granting of patents, ordering that the invention be kept in secrecy, and restricting the filing of foreign applications.

The U.S. Patent and Trademark Office imposes the secrecy orders that DoD recommends. The Armed Services Patent Advisory Board coordinates the review in DoD. Approximately 5,000 secrecy orders are in effect. This number has been fairly constant during the past four years, with about 80–150 new orders issued annually and about 100–200 orders rescinded annually.

The issue of streamlining export controls has been discussed since the end of the Cold War and has gained increased attention over the past several years. A Rapid Improvement Team (RIT) was formed several years ago to deal with export control licensing reengineering.

CONSIDERATIONS

Acquisition Community

Have you identified the potential for export controls up front with potential technology providers? Are the export controls accurately identified and consistent with national security needs?

Many companies have been advised that if their advanced technology (even if relatively benign) is incorporated into a defense system, then they will be subject to an array of export controls that they would otherwise not have to deal with. This has happened in the past. If a technology provider has a dual-use technology with a large overseas potential, you may not get access to the technology. Ensuring that the export controls for a program are necessary and appropriate is essential. You should also make potential technology providers aware of the possibility of future export restrictions.

ISSUE CATEGORY 2: CULTURAL BARRIERS

Every PM is responsible for fostering a culture in which appropriate technology enhancements are promoted throughout the life of a program. Every PM should have a plan for transitioning technology. Unfortunately, cultural barriers for continuously enhancing technology exist in many forms. They can stem from a lack of effective motivation and incentives; poor communications and relationships among the communities; and the failure to use effective procurement strategies for enhancing technology.

Issue 2-A: Using Motivation and Incentives

As with most aspects of human interaction, using motivations and incentives can be a key to success. Techniques, such as incentives, recognition, positive performance evaluations, and bonuses can encourage and support enhancing technology. Money is an all-purpose motivator,

[14] AECA, Title 22 U.S.C. 2278.
[15] ITAR, 22 C.F.R. 125.
[16] Invention Secrecy Act of 1951, Title 35 U.S.C. 181-188.

exerting influence by both by its presence *and* its absence. Cash awards can encourage inventors, and larger budgets can facilitate exploring new technologies. However, the lack of funds can make seeking out newer, more efficient technologies necessary. Competition is another technology motivator. Creating and maintaining technology alternatives helps keep prime contractors motivated.

Evolutionary acquisition relies on using time-phased capability needs in which increasing military capability arrives in successive increments. The DoD acquisition culture tends to be risk-averse, resulting in resistance to change. New technology represents change, change threatens incumbency, and if technology fails, careers and reputations can suffer.

RECOGNITION OF INDIVIDUALS AND ORGANIZATIONS

All Communities

Are you using rewards and awards to encourage and support technology transition?

Send a message that innovators and risk-takers will be rewarded and supported. Whenever possible, use rewards and incentives at all stages in the process. Awards to individual scientists or entire labs have been effective in motivating technology enhancement.

Do you recognize your industry team members when appropriate?

Do not underestimate the effect of non-monetary recognition for your industry team members. Letters, especially from high-ranking government personnel to high-ranking company personnel, plaques, certificates, and other forms of recognition can affect employees positively. This is especially true when specific, concrete accomplishments are cited, and specific individuals are recognized.

Acquisition Community

Is the government staff motivated to identify disruptive technology opportunities?

Processes or procedures for rewarding the insertion of appropriate, but disruptive, technologies can be effective in helping you avoid the cultural barriers that might otherwise thwart enhancing technology.

The government staff must be motivated to identify technology opportunities. Specifically, performance evaluations of civilian PMs, deputies, and military personnel must reflect the importance of embracing new technologies to meet warfighter needs.

Have you nominated S&T community members for awards for technology solutions?

Just as positive reviews of programs are good motivators, so too are awards and public acknowledgements of jobs done well. You should nominate S&T community members for awards for technology solutions. Although rewards for appropriately enhancing technology can be excellent motivators, rewards should also be given to people for planning for long-term sustainment.

CONTRACT INCENTIVES

Acquisition Community

Does the contract offer incentives for continuously inserting and refreshing value-added technology? Are these incentives motivating both the contractor's business and the technical communities?

Ensure that your contract provides incentives for continuously inserting and refreshing value-added technology. These incentives must motivate both the contractor's business and the technical community. For example, award fees measured against a baseline technology insertion plan would help to maintain a focus on technology insertion.

Sustainment Community

Does your acquisition strategy give incentives for improving reliability, maintainability, and reducing Total Ownership Costs (TOCs)?

You should be sure that your acquisition strategy provides incentives for improving reliability, maintainability, and reducing TOCs.

Where practical, the contract should offer the contractor the opportunity to share in savings, either through VE or a share of the savings realized because of technology insertion. Contractor logistics support with shared savings can be used to motivate inserting technologies that have life-cycle payoffs.

Issue 2-B: Relationships

Barriers that limit the relationship among the warfighter/user, S&T, acquisition, T&E, finance, and sustainment communities must give way to a culture that rewards collaboration. The six communities must collaborate to foster joint ownership and to better achieve solutions to technology challenges. Industry also must be included in the collaboration.

CONSIDERATIONS

All Communities

Are you constantly striving to foster effective relationships between the other communities? Are methods available for interacting with these communities?

All communities must constantly strive to foster effective relationships with one another and seek ways to interact with one another. By establishing cross-functional relationships, they identify and communicate best practices, participate in training courses, engage in external communications (e.g., through conferences and symposia), participate in open public forums, exchange lessons learned, and team to develop advance plans.

Issue 2-C: Contract Strategies

Procurement regimes that inhibit inserting value-added technologies or penalize consideration of disruptive technologies inhibit your ability to access and integrate technology into a system.

In its report, *DoD Research — Acquiring Research by Nontraditional Means*,[17] the GAO concluded that the authority for cooperative agreements and OTs for prototype projects appears to have given DoD the tools for using the private sector's technological knowledge and financial

[17] NSIAD-96-11, March 29, 1996.

investment. These instruments have attracted companies, the GAO noted, that traditionally did not do research for DoD, by enabling more flexible terms and conditions than the standard provisions for financial management and IP typically found in DoD contracts and grants. The GAO noted that the instruments also appear to be helping foster new relationships and practices in the defense industry, especially for projects being undertaken by consortia.

Prime contractors may have a natural tendency to prefer internal technology because they can see the design and make it work. Prime contractors may have conflicting objectives about adopting technology from an outside provider, ranging from something as intangible as the "not invented here" syndrome to more tangible issues, such as displacing the prime contractor's revenue base. Primes may also be concerned about complex issues, such as problems with the timeliness and compatibility of technologies built by outside organizations. This last issue is sometimes referred to as a "conflict of motivation."

Acquisition strategies need to include a team approach to solving technology problems. The strategies must be flexible and motivate organizations to use their best talent for government S&T and R&D. Top-notch personnel are a premium resource that the government needs to attract high-quality technology solutions.

CONSIDERATIONS

All Communities

Use performance-based statements of work to clearly establish what the government wants; and, using that information, create performance incentives that encourage contractors to focus on providing value to the government. Having the discipline of firm goals at every stage of the process, especially under spiral development, is important. The government can define its goals (e.g., increased reliability) and measure and reward contractor performance against those goals through business arrangements, such as award-fee and incentive-fee contracts. Historically, the choice of contract type has been the primary strategy for structuring contractual incentives, but performance incentives can be used in conjunction with various contract types and are not associated with one type of contract.

Examine both financial performance incentives, with values derived from the worth of increased performance to the government, and non-financial performance incentives, such as long-term contracting.

Attract top-notch resources to create high-quality technology solutions by including fair and reasonable IP provisions. To provide incentives, allow commercial firms to retain their IP rights in key areas. Avoid using onerous government-unique provisions (e.g., an unneeded requirement for cost and pricing data, when other pricing methods can be used). Flexible business instruments can help.

S&T, R&D, and Acquisition Communities

Are strategies in place for mitigating potential conflicts of motivation or disincentives to adopting new technologies on the part of prime contractors, government labs, and commercial labs?

Use peer reviews to vet technology recommendations and solutions. This technique promotes greater integrity, but attracting the appropriate peers can be difficult. The peer team could include members from academia, small and large businesses, laboratories, and the acquisition

community. Ideally, the peer reviews can be supported under a contractual arrangement in which participants are paid a stipend for their professional expertise and must sign appropriate non-disclosure statements.

Another technique for mitigating potential conflicts of interest or disincentives is to continually consider alternatives to the current solutions. Some PMs do this by aggressively pursuing SBIR programs. They contribute to the topics when the solicitations are being developed, help evaluate proposals, track the development of technologies, and continually evaluate the potential of using the technologies in their programs. Once an SBIR technology matures sufficiently to be considered for funding, you can use a peer review to determine risk and plan for implementation. Resistance from internal and external forces must be eliminated by objectively bringing the best technology to the warfighter at the lowest total ownership cost. The disruption that might occur from selecting an alternative technology may well be worth it in the end. Understanding this resistance and developing strategies to neutralize it is a major challenge.

Acquisition Community

Is continually inserting and refreshing value-added technology included in acquisitions?

By making continual value-added technology insertion and refreshment a contract deliverable, you can help ensure your program is acquiring state-of-the art technologies that will remain current throughout the life of the project. Your technology refreshment strategy should be tailored to the particulars of the program to provide cost-effective support and upgrade strategies to keep the program ahead of the obsolescence curve. The acquisition community's support of the technology refreshment strategy is essential to ensure that the procurement method supports its approach. Open systems architecture using standard commercial interfaces wherever possible is one cost-effective strategy designed to do this.

A technology refreshment strategy has other benefits as well. For example, the strategy should result in regular upgrades instead of major end-of-life modifications or follow-on systems. The performance, reliability, availability, and readiness of the program should improve by using newer generation technology. Demands of the sustainment community should decline because "pull and replace" components interfacing with open systems require less supply chain support or, alternatively, rely on the support of contractor logistics. These are only a few of the benefits that you may accrue from developing a sound strategy.

Do you have effective methods for creating competitive alternatives in your system?

Feedback from industry is essential for you to be able to understand the feasible alternatives. "Flying blind" instead of exploring viable options can greatly reduce the probability of your program's success. Develop methods of making the prime contractor a systems-interface manager who brings multiple technologies into the fold. Do not rely on home-grown technology, or let parochial interests thwart the objective consideration of external technology.

Do you have effective means of planning to mitigate risks?

Effective planning for mitigating risks also is important for overcoming the barriers to continually enhancing technology. Consider trying advanced technology products and having a peer review of the technology to help decide which new developments to incorporate. Once the

technology is incorporated, use a build-test process that relies on early data feedback from the field to drive design changes.

Do you use profit incentives to encourage contractor use of innovative technologies?

In response to congressional desires to encourage contractors to use innovative technology, DoD modified its weighted guidelines profit policy to add a special factor when contractors use innovative technology. This factor is intended to offer higher negotiated profits to contractors who use innovative technologies. You need to ensure that your contracting officers are using this special added factor when forming the profit objectives.

Sustainment Community
Are you using performance-based specifications?

Stating a requirement by specifically describing the design specifications of the deliverable inhibits the program's ability to incorporate new technologies that might meet the same performance requirements better and less expensively. Use performance-based specifications to maximize flexibility for inserting technology. Under performance-based approaches, the government outlines a desired outcome — rather than specifying a required approach — and relies on industry to provide solutions. In general, performance-based contracts are fixed-price contracts, unless the contract deals with non-recurring development. The key to performance-based acquisitions is structuring the requirement so it clearly specifies what is needed but does not detail how that need is to be met. Structuring acquisitions in this manner enables the contractor to provide its most efficient solution. The government can expect competitive solutions that are successful in the commercial marketplace and increased participation by non-traditional suppliers.

ISSUE CATEGORY 3: KNOWLEDGE MANAGEMENT
Sharing of technical knowledge both in and among organizations are two essential elements of the collaboration required to ensure that technology enhancements are integral to the life of the product. Fostering a culture in which information sharing is the norm avoids repeating past mistakes, saves time, stimulates exchanging knowledge, fosters serendipity, eases communications, and leads to an exchange of ideas. A knowledge management system, or approach that facilitates these results, is a technique that will enable you and your organization to capture, build on, and disseminate technical information. Knowledge management, as a system, could be Web-based or supported by software. It could also be a monthly gathering organized around a germane topic with short presentations and question-and-answer sessions.

Issue 3-A: Making Contact
One element of knowledge management involves the oldest form of communication — word of mouth. This remains an effective form of knowledge management and can be done through meetings, informal conversations, seminars, and conferences.

Inserting technology often is a contact sport — a one-on-one exchange that brings together information about user needs, technological possibilities and barriers, and program planning options.

As the developers of technologies, members of the S&T community are a critical conduit or contributor to technical information. The S&T community needs to keep current with

technology, often through personal interactions at conferences, symposia, and academic meetings. Interpersonal exchanges of technical information must include the acquisition community because of the consistent influx of information received in program offices. Sharing your program's successes or knowledge can help to ensure the success of a similar program.

To overcome the cultural resistance to sharing knowledge, you need to show a strong commitment, develop and implement a plan for managing knowledge, provide incentives to reward the desired behaviors, and build a system or mechanism of promoting information flow, especially for using technology.

A key reason why technology transition can be challenging is that it requires the collaboration of five diverse communities — capability needs, S&T, R&D, acquisition, and sustainment. Each group has a vital and unique mission that leads to different cultural perspectives when transition is required. Effective transition requires these communities to work together as a team, which frequently is problematic.[18]

CONSIDERATIONS

All Communities

What communication venues exist for enhancing technology insertion?

Successful communication is the cornerstone of collaboration and teamwork. The best opportunities for the players to communicate are available through neutral forums, such as Web sites and seminars. These venues enable the players to share success stories and information about available technology. One such example is the Defense Science and Technology Seminars on Emerging Technologies, initiated in 1998 to promote dialogue among military leaders, members of the defense science and technology community, and leading researchers from industry and academia, about topics of growing importance to DoD. The monthly seminars feature short presentations by distinguished researchers who give useful insights about a technology area offering significant military payoffs. The response from the community since the seminars began has been overwhelmingly positive. Another venue is simulations of technology insertion, in which the communities participate in a simulation of an actual program and assess the effects of the technology.

Capability Needs Community

Do you invite S&T and acquisition staffs to attend meetings in which warfighters are discussing future needs and lessons learned?

Having the S&T and acquisition communities routinely interact with warfighters keeps them informed about the shortcomings of current equipment and needs for future capabilities. The best technology personnel are those who understand both their technical area and the future warfighting environment. One way to do this is to ensure that S&T personnel have copies of current warfighting capability needs documents. The S&T community should be invited to brief about the technologies that they are developing to address capability shortfalls and receive feedback to assist in prioritizing their efforts.

[18] USD(AT&L), June 2001 report to the congressional defense committees on alternative approaches for ensuring that successful research initiatives are fielded timely. Required by the NDAA for FY01.

S&T Community

Do you participate in informal communication gatherings?

You can foster technology application through a variety of methods. Perhaps the easiest is participating in informal communication gatherings, where you can highlight the technologies with which your community is involved and their anticipated applications.

How well are your technology developments showcased in project demonstrations for the capability needs and acquisition communities?

Another way to highlight developments is by showcasing them in product demonstrations for the capability needs and acquisition communities. For example, the Navy hosts an annual Naval-Industry R&D Partnership Conference that offers the following:

- Partnership opportunities through the networking/showcase marketplace;
- The latest updates about naval needs and requirements;
- Information about innovative products and cutting-edge research;
- Expert advice about transitioning technologies into products; and
- One-on-one-meetings with venture capitalists and technology commercialization organizers.

This conference, and similar ones in other Services, are valuable forums for you to discuss your technology with representatives of the S&T and acquisition communities.

Are you encouraging staff exchanges or liaisons with programs as a way of fostering technology transition?

You can foster technology transition through staff exchanges or liaisons with programs. For example, the ONR has an exchange program with the major Navy PEOs, specifically to be the link between the S&T and acquisition communities. This exchange program helps to improve the possibilities for transitioning technology into weapons systems.

Are you taking advantage of temporary personnel assignments with industry?

Similarly, information can be exchanged through programs that enable personnel to be assigned temporarily with industry. Such programs are gaining popularity.

R&D and Acquisition Communities

Are you encouraging staff exchanges with the S&T community as a means of fostering an understanding of program needs?

Encouraging staff exchanges with the S&T community is one way of fostering an understanding of program needs. Discussing what needs fixing helps technology providers focus their attention and resources in technology areas that add value. By identifying your program's challenges instead of the solutions, you free the technology provider to offer options with a variety of trade-

offs between risk and performance. Giving the S&T community some flexibility permits different approaches to be pursued simultaneously.

Are you participating in public forums, seminars, research conferences, and other venues to share your technology needs and identify potential solutions?

Because these events are well attended by the technology providers, there is an opportunity to galvanize resources to solve a program's challenges. But you cannot do it by staying in your office. If you do, you are left to depend on the incumbent team.

Issue 3-B: Lessons Learned

Lessons learned refer to knowledge or understanding gained from experience. The usefulness of lessons learned is an understanding of the factors that contribute to avoiding failure and those that lead to success. Without adequate knowledge of what has occurred before, pursuing policies and processes that lead to successful outcomes is difficult. To be effective, lessons learned should be generalized to protect classified or proprietary data.

CONSIDERATIONS

All Communities

Do you participate in forums to share lessons learned?

The sharing of lessons learned, within and among all communities, is important. Representatives of the capability needs, S&T, acquisition, and sustainment communities should participate in forums available for sharing lessons learned.

From an operational perspective, Services maintain lessons-learned data that may be useful to technology providers. See the Army's Center for Lessons Learned site at http://call.army.mil/ for an example of this type of resource.

You should also consider sharing problems you encounter during the budgetary process along with ways for avoiding the problems. You can share these insights directly with the personnel in your financial community who work on RDT&E issues. If you have more far-reaching concerns or suggestions, there is an annual conference that attracts a large number of financial personnel. You can contact the American Society of Military Comptrollers, which organizes the conference, if you would like to participate in their workshops. More information is available at http://www.asmconline.org/.

To provide a forum for the Acquisition, Technology, and Logistics (AT&L) workforce to share knowledge with fellow practitioners, the Defense Acquisition University (DAU) has established the Acquisition Community Connection (ACC). The ACC is a virtual community where functional area experts, program managers, and industry partners can meet online to share knowledge and help each other bring new technologies to the field faster and cheaper. Currently, there are separate areas for contracting, logistics, risk, systems engineering, and program management, among others. The ACC can be accessed at http://www.acc.dau.mil.

Sustainment Community

Do you use effective methods for communicating sustainment challenges?

Communicate sustainment challenges to help the other communities make wise technology choices earlier in the program cycle. Work with organizations specializing in outreach, such as the National Technology Transfer Center. Founded in 1989, the NTTC is a leader in technology transfer and commercialization. Guided by its vision to aid economic development by mapping technologies needed to technologies available, the NTTC has a complete portfolio of products and services that enable U.S. companies to find technologies, facilities, and world-class researchers in the federal labs and agencies with which they can partner. NTTC is replete with lessons learned. You can access NTTC's Web site at http://www.nttc.edu/.

Issue 3-C: Information Access

An information access system, mechanism, or approach is simply the tool or technique the PM uses to foster a culture in which all benefit from individual successes and lessons learned. When possible, you must develop a culture that thrives on refreshing technical knowledge so your community can be an information source for the latest and greatest trends, ideas, and technologies. Access to information about technology applications will support your community's technical currency, assist in maintaining contact with private industry, and contribute to the knowledge base of ideas in your disciplines. The importance of effectively accessing information extends to the sustainment community, which needs access to lessons learned, successes, and other such information to creatively sustain a system.

CONSIDERATIONS

All Communities

Do you have access to, and do you use, the Defense Technology Information Center (DTIC) IR&D database and other relevant S&T databases?

One forum for obtaining information about IR&D projects and results is the DTIC IR&D database.[19] Participation in the database is voluntary, and contractors will add their data only if they perceive some benefit from it. Use it, contact companies, get the word out that the database is important, and you can help the database to grow. In addition to the IR&D database, the Virtual Technical Expo[20] contains information about emerging technologies, including descriptions of technology advancement, projected benefits, project milestones, and expected year of completion, in the following categories:

- air platforms
- battlespace environment
- biomedical
- chemical and biological defense
- ground and sea vehicles
- human systems

[19] Access is limited to government agencies. For more information, visit http://www.dtic.mil/dtic/submitting/ird.html.

[20] The VTE can be accessed at https://vte.dtic.mil. See Appendix B for more information.

- information systems technology
- materials and processes
- nuclear technology
- sensors, electronics, and electronic warfare
- space platforms
- weapons

This resource should continue to grow as DDR&E promotes its use and funds its expansion.

S&T and R&D Communities

Do you use a particular strategy for maintaining technology currency?

A strategy for maintaining technology currency in these communities would encompass both the "push" and "pull" of knowledge. At government labs, a key objective is to push out technology developed by the government so commercialization potential is realized. The technology may then come back to the government in the form of useful products. Equally important is the extensive amount of investment being made by the commercial sector that should be accessed by the prime contractors and government labs. You should help achieve this result by attending important technology conferences, collaborating on research projects with commercial industry, maintaining open dialogue and objectivity about commercial possibilities, and guarding against the "not-invented-here" syndrome that might thwart an objective review of potentially disruptive technologies.

Do you maintain awareness of joint and Service future warfighting concepts?

Knowledge of future warfighting visions and concepts, and other existing S&T programs, will help you develop applications for your technologies. *Joint Vision 2020* and Service vision documents will help you understand the warfighters' best guesses about the capabilities they will need in the future. The vision documents outline the capabilities that will be needed for the future, and how they will be used. The documents leave most of the details about how to provide the capability to the technology and acquisition communities. They seek truly transformational applications of technology that will springboard warfighting capability ahead. This can be done through applying either new technology or existing technology innovatively. These vision documents use the taxonomy, concepts, and language that the warfighter will use to highlight capability shortfalls. Knowing the meaning of key operational concepts, such as "full dimensional protection" and "focused logistics," will assist you with providing the enabling technologies for future warfighting capabilities.

Do you remain current about defense technology objectives and implementation plans?

Remaining current about defense technology objectives and implementation plans can help your community ensure its developments will have useful and current applications. Without staying abreast of defense program plans, your community could make investments that do not have any

application in the warfighter community. One way to avoid this outcome is to review emerging capability needs documents.

S&T, R&D, and Acquisition Communities

Do you know about, and have access to, non-traditional companies' technology solutions?

A number of processes and resources for accessing information are available to the acquisition community. Non-traditional businesses, both large and small, often are the greatest innovators. You should seek information about, and access to those companies' technology solutions. A technology manager who is not responsible for executing a program could be your outreach agent. He or she should constantly review possible sources of technology outside the contractor base.

Do you maintain an awareness of DoD, Service, and defense agency S&T and R&D plans for program application?

The DoD, Service, and defense agency S&T and R&D plans are a quick way of understanding ongoing technology programs in your area and in related areas that may affect your program.

The *Defense Science and Technology Strategy* contains the DoD-level documents that connect the S&T community with the warfighter's future operational needs. The DoD plans are complemented by Service and defense agency (for those defense agencies with S&T responsibilities) plans that outline programs in their areas of responsibility. In the defense S&T strategy, the programs outlining the 6.2 and 6.3 programs that will be transitioning are shown in the Defense Technical Area Plan (DTAP) and the Defense Technology Objectives (DTOs). The DTAP documents the focus, content, and principal objectives of the overall DoD S&T effort. The emphasis is on programs that transition technology rapidly to the operational forces. The DTAP is organized by technology areas and gives a horizontal overview of programs from all Services and agencies. This overview includes more than 300 specific technology efforts, including ACTDs and other initiatives, with information about summary costs, schedules, and goals. Each DTO shows a specific technology advancement that will be developed or demonstrated, provides a projected date of availability, and lists the anticipated benefits that the advancement will provide.

Similar Service and defense agency documents, such as the *Army Science and Technology Master Plan* (ASTMP), complement the DoD-level plans and contain information about additional initiatives. These documents provide good overviews of programs, a sense of what is coming up for transition, and some information about funding levels. Reviewing them is a good first step to gaining information about programs and initiatives.

R&D roadmaps and similar documents contain equivalent information about R&D programs.

Does the technology provider (government lab, commercial firm, etc.) have a process to mine current relevant technology and assess future trends?

The technology provider (government lab, commercial firm, etc.) should use information technology to identify key investments by DoD in technology. Your community should encourage this. For example, the DDR&E plans to develop a fault-tolerant information resource that gives all internal defense technology providers access to the myriad ongoing projects in

DoD. Defense labs also should be accessing other available commercial research databases to exploit commercial technology.

CONCLUSIONS

Hopefully, these challenges and considerations will help you put technology transition into practice within your organization. Consider the themes in this chapter and the preceding chapters as you engage in this "contact sport."

- Understand the interests of industry and the other communities.
- Promote early and continual communication between the communities responsible for technology transition. The IPPD process can help with this.
- Keep an eye open for new and better technologies. Some may come from non-traditional sources and small businesses.
- Identify and overcome potential barriers as early as possible.
- Use the flexibility that you have within the process to reduce barriers, such as IP issues.
- Keep the warfighter in mind. Your work is important, and your ultimate customer, the men and women in the armed Services, deserve the best products that this nation can provide.

APPENDIX A
KEY RESOURCES

This Appendix contains information on programs that support the Department of Defense (DoD) technology transition activities. All the Web sites were active at the time of publication. The electronic versions of this document contain active links that may assist in accessing the sites.

ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS

- *Introduction to Advanced Concept Technology Demonstrations (ACTDs)*. Available on the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics) (OUSD(AT&L)) Web site at http://www.acq.osd.mil/actd/intro.htm.

- OUSD(AT&L) Guidelines are available at http://www.acq.osd.mil/actd/guidelns.htm.

DOD PLANNING, PROGRAMMING, BUDGETING AND EXECUTION SYSTEM

- Management Information Decision 913 of May 22, 2003. http://akss.dau.mil/darc.

DOD REQUIREMENTS GENERATION SYSTEM

- Chairman of the Joint Chiefs of Staff Manual 3170.01, *Operation of the Joint Capabilities Integration and Development System*, June 24, 2003 http://akss.dau.mil/darc.

DOD SERIES DOCUMENTS

- DoD Directive 5000.1, *The Defense Acquisition System*, May 12, 2003. http://akss.dau.mil/darc.

- *The Defense Acquisition Guidebook* (formerly DoD Instruction 5000.2-R). http://akss.dau.mil/darc.

DUAL-USE SCIENCE AND TECHNOLOGY

- *Dual Use Science and Technology Process: Why Should Your Program Be Involved? What Strategies Do You Need to Be Successful?* Deputy Under Secretary of Defense (Science and Technology) (DUSD(S&T)), Office of Technology Transition, July 2001. Includes appendix about Technology Investment Agreements (TIAs). http://www.dtic.mil/dust.

- *Dual Use Technology: A Defense Strategy for Affordable, Leading-Edge Technology*, OUSD(AT&L), February 1995.

- *Army Science and Technology Master Plan 2001*, the Department of the Army. Also addresses technology transition issues.

GRANTS AND COOPERATIVE AGREEMENTS

- *Grant or Cooperative Agreement*, DoD Grant and Agreement Regulatory System (DoDGARS). http://www.dtic.mil/whs/directives/corres/html/32106r.htm.

INFORMATION AND ANALYSIS CENTERS

- The Air Force Research Laboratory's Technology Information Clearinghouse. Telephone number 1-800-203-6451 or Web site at http://www.afrl.af.mil/techconn/index.htm.

- The Defense Technical Information Center (DTIC) has Information and Analysis Centers (IACs) to help users locate, analyze, and use scientific and technical information. Staffed by experienced technical area scientists, engineers, and information specialists, the IACs establish and maintain comprehensive knowledge bases, including historical, technical, and scientific information collected throughout the world and pertinent to their respective technical communities. They also collect, maintain, and develop analytical tools and techniques, including databases, models, and simulations. http://iac.dtic.mil/1_about/about_iacs.htm.

INNOVATION

- *Technology Horizons* is a magazine that features exclusive reports of innovative technologies developed under the Air Force Research Laboratory's (AFRL's) multi-billion-dollar R&D budget. Each issue contains briefs about AFRL's best new inventions that are available to help industry develop products that meet their toughest engineering challenges — as well as features highlighting Air Force research programs, partnerships, contracts, and success stories. http://www.afrlhorizons.com/.

INTELLECTUAL PROPERTY PROVISIONS

- *Intellectual Property: Navigating Through Commercial Waters*, OUSD(AT&L). The report discusses issues and solutions for dealing with intellectual property rights. Version 1.1, October 15, 2001, is available through a link at http://www.acq.osd.mil/dpap/Docs/intelprop.pdf.

"OTHER TRANSACTIONS" FOR PROTOTYPE PROJECTS

- *Other Transactions (OT) Guide for Prototype Projects*, OUSD(AT&L), December 2000.

- *Department of Defense Report on Other Transaction Awards for Prototype Projects*. February 1999 and February 2000. Also discusses COSSI.

- *Guide on Section 845/804 OTs for Prototype Projects*. November 1998.

S&T TRAINING

Defense Acquisition University, http://www.dau.mil.

SHARE-IN-SAVINGS PROVISIONS

- *Development of Innovative Contract Initiatives*, the draft Breakthrough Rapid Improvement Team Report, Department of Defense Change Management Center, October 4-5, 2000, contains a discussion of Share-In-Savings (SIS) provisions in Section VI.

SMALL BUSINESS INNOVATION RESEARCH

- *Small Business Innovation Research (SBIR) Program*, sixth edition, OUSD(AT&L).

TECHNOLOGY INVESTMENT AGREEMENTS

- *Technology Investment Agreement (TIA)*, DoDGARS. A short electronic guide at http://alpha.lmi.org/dodgars/tias/tias.htm.

TECHNOLOGY TRANSITION

- *Report to Congress on the Activities of the DoD Office of Technology Transition*. March 2004.

- *Spinoff*, The National Aeronautics and Space Administration (NASA). NASA's annual publication featuring successfully commercialized NASA technology.

- *Technology Transition for Affordability: A Guide for S&T Program Managers*, Deputy Under Secretary of Defense for Science and Technology (DUSD(S&T)). April 2001.

UNSOLICITED PROPOSALS

- *Unsolicited Proposal Guide*, Air Force Materiel Command. Pamphlet 64-101. June 1997.

- *Guide for Unsolicited Proposals*, Army Materiel Command. Pamphlet 70-8. May 1998.

- *Unsolicited Proposal Handbook*, Bureau of Reclamation. August 1998.

APPENDIX B
ADDITIONAL WEB SITES

This Appendix provides a list of Web sites that contain information on topics related to technology transition. Each entry includes a brief description of the site and its address. Electronic copies of this document contain active links to the sites. The Web site listing beginning on page B-4 is for informational purposes only and does not in any manner denote endorsement by the Department of Defense. The DoD has no control over the content of these commercial sites.

U.S. GOVERNMENT SITES

Advanced Concept Technology Demonstrations (ACTDs)
The ACTDs Web site discusses ACTD's accomplishments, lists points of contact, and contains articles and speeches, guidelines, and more. http://www.acq.osd.mil/actd/.

Air Force Research Laboratory's *AFRL Technology Horizons*
The AFRL's quarterly technology magazine, *AFRL Technology Horizons*, is available online at http://www.afrlhorizons.com/.

Best Manufacturing Practices (BMP)
The BMP program is a unique partnership between industry and government for transferring technology that improves the global competitiveness of the U.S. industrial base. The program's site highlights news, software, surveys, library, and more. http://www.bmpcoe.org/.

Defense Advanced Research Projects Agency (DARPA)
DARPA is DoD's central R&D organization. The DARPA site contains information about the agency mission and overview, offices, news releases, budget information, and solicitations. http://www.darpa.mil/.

Defense Production Act Title III Program
The Defense Production Act Title III Program creates, modernizes, or expands domestic production capability and capacity for technology items, components, and industrial resources essential for national defense. http://www.dtic.mil/dpatitle3/.

Defense Technical Information Center (DTIC)
A key element of the DoD Scientific and Technical Information Program, DTIC is the central DoD facility for accessing and facilitating the exchange of S&T information. The DTIC site describes the variety of products and services available from DTIC that are designed to help users obtain the information they need easily and quickly. DTIC is part of the Defense Information Systems Agency (DISA). http://www.dtic.mil/.

Department of Defense Office of Technology Transition (OTT)
The OTT Web site contains information about, and links to, the OTT's programs. http://www.dtic.mil/ott/.

Dual Use Science and Technology (DUS&T) Program
The DUS&T program's Web site details the DoD's DUS&T program. The site includes a fact sheet, project information, guidance, and success stories. http://www.dtic.mil/dust/.

Federal Government Technology Transfer Links
The Manpower and Training Research Information System (MATRIS) project offers hyperlinks to Federal Government technology transfer programs. http://www.dtic.mil/matris/.

Federal R&D Project Summaries
Federal R&D project summaries are a portal to information about federal research projects, complete with full-text single-query searching of databases at different agencies. The site also is a unique window to the federal research community, enabling agencies to better understand the R&D of their counterparts in government. http://www.osti.gov/fedrnd/about.html.

Federal Research in Progress (FEDRIP)
The FEDRIP database gives access to information about ongoing federally funded projects in the physical sciences, engineering, and life sciences. The ongoing research announced in FEDRIP is an important component of transferring technology in the United States FEDRIP is a non-bibliographic information source for research in progress. Use FEDRIP to:

- avoid duplicating research,
- locate sources of support,
- find leads in the literature,
- stimulate ideas for planning,
- identify gaps in areas of investigation,
- locate individuals with expertise, and
- complement searches of completed research.

FEDRIP offers a free trial and day pass; a membership fee is charged for long-term use. http://grc.ntis.gov/fedrip.htm.

GOV Research Center
The GOV Research Center is a joint venture between the U.S. Department of Commerce's National Technical Information Service (NTIS) and the National Information Services Corporation (NISC) for a single access point to valuable government information. This joint venture combines NISC's award-winning technology and NTIS's valuable content. The service is entirely Web-based and has information that professionals worldwide can easily access. Scientists, engineers, and researchers will find NISC's powerful search engine enables broad-

based, refined search and retrieval capabilities. Individual or network subscribers can search in different modes to retrieve the most complete and relevant data available. The site offers a free trial and day pass; a membership fee is charged for long-term use. http://grc.ntis.gov.

Independent Research and Development
DTIC's independent research and development (IR&D) database contains voluntary submissions from industry of their IR&D projects. DoD employees can search the database to find IR&D projects that could fulfill defense requirements. Each project is described briefly and a point of contact is given for the appropriate contractor organization. Each project is categorized to facilitate searching and analysis by technology area or application. Currently, the database contains about 4,000 active projects valued at more than $4 billion. http://www.dtic.mil/ird/.

Joint Experimentation (JE) Program
The U.S. Joint Forces Command (USJFCOM) is DoD's transformation laboratory. USJFCOM's JE campaign plans are the framework for synchronizing all Services to ensure that our forces are more effectively used on the basis of improvements in doctrine, interoperability, and integration. http://www.jfcom.mil/about/experiment.html.

National Aeronautics and Space Administration's (NASA's) Commercial Technology Office (CTO)
The mission of the NASA's CTO is to increase the competitiveness of U.S. industry by using NASA technologies, expertise, and facilities commercially. Three steps occur as the CTO aims to do its mission. The first step is to manage intellectual property (technologies, expertise, and facilities). The next step is to promote the opportunities that NASA technologies, expertise, and facilities give industry and other government R&D programs. In the last step, NASA works with partners who use NASA capabilities to improve their competitive edge and promote economic growth. http://technology.grc.nasa.gov/.

National Aeronautics and Space Administration's TechFinder
NASA's TechFinder is the commercialization portal for all available NASA technology transfer success stories. TechFinder contains text and images from all 11 NASA centers. TechFinder is updated within minutes of changes made at a NASA field center. The site has a free database search. http://technology.nasa.gov.

National Institute of Standards and Technology (NIST)
The NIST site contains information about NIST technology, measurements, and standards programs, products, and services. http://www.nist.gov.

North American Technology Industrial Base Organization (NATIBO)
Sponsored by the OTT, the NATIBO Web site assists with promoting a cost-effective, healthy technology and industrial base that is responsive to the national and economic security needs of the United States and Canada. http://www.dtic.mil/natibo/.

Small Business Innovation Research (SBIR) Program
The DoD SBIR Program Web site contains SBIR process information, lists of current solicitations, and an SBIR Help Desk telephone number. http://www.acq.osd.mil/sadbu/sbir.

Small Business Technology Transfer (STTR) Program
The DoD SBIR Web site also has information on the program. http://www.acq.osd.mil/sadbu/sbir.

Tech Connect
The Tech Connect Web site is a gateway for the AFRL clearinghouse for technology information, which is free of charge to government, industry, and academic customers. Customers call, e-mail, or fax their requests about technology subjects, and Tech Connect analysts research the subjects in AFRL, the Air Force, other DoD Services, and the federal lab system, to find ongoing research programs or technical focal points. http://www.afrl.af.mil/techconn/index.htm.

Technical Support Working Group (TSWG) Broad Agency Announcement (BAA) Information Delivery System
The TSWG BAA information delivery system enables users to check postings regularly and participate in the rapid research, development, and prototyping of technologies to combat terrorism. Consult Federal Business Opportunities at http://www.fedbizopps.gov to review postings of other government development or contracting opportunities.

All visitors can download active BAA solicitations from this site; however, you must register and have an active registration on the site to submit a response. http://www.bids.tswg.gov/tswg/bids.nsf/Main?OpenFrameset&5C7Q8NTechnology%20Horizons.

TechTRANSIT
The OTT's TechTRANSIT Web site provides access to DoD technology transfer programs, policies, and resources. http://www.dtic.mil/techtransit/.

Virtual Technology Expo
The Virtual Technology Expo, sponsored by the DUSD(S&T), gives the defense community access to the latest in research in the DoD. The site is accessible only to government employees, but in the future will accommodate several levels of security access and S&T partners from industry. Password protected site: https://vte.dtic.mil/.

COMMERCIAL AND OTHER WEB SITES
American Association for the Advancement of Science's R&D Budget and Policy Program
Since 1976, the American Association for the Advancement of Science's R&D Budget and Policy Program has sponsored studies of and colloquia about funding and policy issues affecting R&D. The program provides timely, objective, and accurate information about federal R&D support. The Web site supplements the program's annual reports on R&D funding. http://www.aaas.org/spp/dspp/rd/.

Community of Science (COS), Inc.
COS brings together the world's most prominent scientists and researchers at more than 1,300 universities, corporations, and government agencies worldwide. COS has tools and services, including COS Expertise, a database of detailed, first-person profiles of more than 480,000 R&D professionals; COS Funding Opportunities, a source of grant information on the Web; COS Abstract Management System, an online publishing solution for universities and professional societies; and customized access to a range of professional reference databases. A notification

service is free for individuals; subscriptions are free for groups and institutions. http://www.cos.com.

CHI Research, Inc.
CHI Research is a research consultancy for technology and science metrics and value-added patent databases. CHI databases incorporate post-issue patent reassignments; company structures adjusted for mergers, acquisitions, and divestitures; more than a million unified non-patent references; and an advanced set of patent indicators. Custom reports can be obtained for a fee. http://www.chiresearch.com.

Community Research and Development Information Service (CORDIS)
CORDIS is a free service from the European Commission's innovation program. CORDIS gives information about European Union research and innovation development. The timely and comprehensive coverage of community R&D helps you:

- identify assistance for exploiting or further developing research results,
- keep up to date on current research findings and strategic directions,
- identify various funding sources for R&D,
- find partners who will cooperate in R&D activities and share expertise, and
- promote and locate transferable technologies.

Visit the CORDIS Web site at http://fp6.cordis.lu/fp6/subprop.cfm.

Dawnbreaker
Dawnbreaker is a professional services firm providing commercialization assistance to advanced technology firms and their investors. Dawnbreaker specializes in business planning, market research, and negotiations using a blend of individualized mentoring, training seminars, and consulting. Two distinguishing features characterize Dawnbreaker's work: (1) the emphasis on measurable results; and (2) the use of a process to grow clients' businesses. Fifty percent of the clients receive private-sector financing within 18 months after developing business plans. Dawnbreaker has worked with more than 400 advanced technology firms through the Small Business Innovation Research Program, Advanced Technology Program, and Environmental Management. http://www.dawnbreaker.com.

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University Ventures, Inc.
The University Ventures site joins those seeking cutting-edge technologies with the universities and institutions that are developing these innovations. The portal helps reshape the emerging technology transfer industry by using the Internet to accelerate the transfer of university-created technology. The portal uses the Internet to provide online resources and business opportunities to universities and businesses in the technology transfer community. UVentures.com is a central marketplace for electronically exchanging information between licensors who list in its database information about technologies they want to license, and prospective licensees who browse and query the database looking for information about specific technologies. Free search capability; fee to list technology. http://www.uventures.com/servlets/.

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APPENDIX C
SUCCESS STORIES

The following success stories were taken from a number of sources (see footnotes in each category). We use the stories to help readers envision how the different programs described in this Guide can benefit the warfighter. A quick index of these stories follows.

In addition to these success stories, some excellent and more detailed success stories about programs for inserting technology into legacy systems are in an Office of the Secretary of Defense (OSD) Office of Technology Transition (OTT) document, *Improving Warfighting Capabilities by Rapidly Inserting New Technology into Legacy Systems*, October 30, 2002.

The lessons in these success stories must be used properly. Action taken for improving processes must be appropriate for your specific situation. Not all lessons are applicable to all situations. These programs show how you can influence and improve transitioning technology in DoD.

USE OF OTHER TRANSACTIONS AGREEMENTS

Evolved Expendable Launch Vehicle (EELV) (Air Force)

The EELV program has used the two largest OTs issued by the DoD to date, with $1 billion going to two contractors, Boeing and Lockheed Martin, who also invested $500 million each. These OT agreements were for developing a family of launch vehicles, services, and supporting systems that will significantly reduce the LCC compared to the LCCs of today's systems. The reductions were reflected in the follow-on Part 12 commercial launch services contracts.

Members of the EELV team from the Air Force and the Aerospace Corporation received the David Packard Excellence in Acquisition Award in 1999, DoD's highest award for acquisition. The team also won the Secretary of the Air Force John J. Welch Award for Excellence in Acquisition Management, the DoD Value Engineering Achievement Award, and the Secretary of the Air Force Strategic Acquisition Reform Award for Contracting. In May 2002, in just under five years, Boeing designed, developed, and rolled out a totally new Delta IV rocket for public viewing.

Global Hawk (Air Force)

The Defense Advanced Research Projects Agency (DARPA), with the Air Force, Navy and Army participating, developed the Global Hawk system between 1994 and 1999 for the Defense Airborne Reconnaissance Office (DARO). The Air Force assumed control in 1999. The program was executed using OT authority, allowing extreme flexibility in managing the program.

The U.S.-led air and missile strikes against the Al-Qaeda terrorist network and Taliban regime in Afghanistan on October 7, 2001, were preceded by the first operational deployment of the Global Hawk high-altitude, long-endurance Unmanned Aerial Vehicle (UAV), seven years after a performance-based Statement of Work (SOW) for the desired system was introduced. A record-breaking aircraft in its own right — it was the first UAV to fly non-stop across the Pacific — the

Global Hawk has been rushed from its development phase into becoming one of the U.S.-led coalition's most valuable reconnaissance assets during operations in Afghanistan and Iraq. The major OT advantages demonstrated are as follows:

- program management flexibility,
- contractor-led Integrated Product Teams (IPTs),
- focus on military utility assessment as a goal of program, and
- elimination of costs for DoD- and Federal Acquisition Regulation (FAR)-based compliant processes and reporting.

DD 21 (Navy)
The Navy's program for a next-generation surface combatant, called DD 21, was being conducted under the authority of Section 845 of the National Defense Authorization Act of FY94 (Public Law 103-160), Section 804 of the National Defense Authorization Act for FY97 (Public Law 104-201), and Title 10 U.S.C. Section 2371. This acquisition approach provided greater market competition and increased industry innovation and design flexibility by using commercial products and processes. Although the program was changed (and renamed DDX) to reflect new budgetary restrictions, the OT agreements with the blue and gold teams were successful.

The National Defense Authorization Act sets aggressive affordability goals that were achieved by involving the contractor early, using state-of-the-art engineering tools to enable "virtual prototyping" and Analysis of Alternatives (AoA) before beginning construction, and using "Cost as an Independent Variable" (CAIV) criteria.

X45A Unmanned Combat Aerial Vehicle (UCAV) (DARPA/Air Force)
The UCAV demonstration program started with a Phase I solicitation in March 1998, and four awards. The program down selection was made in March 1999, and is being done under a $191 million, 56-month cost-share OT agreement that DARPA and the Air Force awarded to Boeing in March 1999. Boeing's share was $21 million.

Initial flight tests began May 22, 2002, less than 50 months after the program began. If the demonstration program is successful, DoD could begin using UCAV weapon systems as early as 2008. This is an example of using an OT to enable flexibility in managing a program and of a spiral development acquisition strategy.

DUAL USE SCIENCE AND TECHNOLOGY (DUS&T)
Advanced Motor Drive (AMD)[1]
The Air Force Research Laboratory (AFRL) Propulsion Directorate Advanced Motor Drive (AMD) project focused on developing an electronic motor drive to replace hydraulic systems in aircraft, and supporting the Air Force's More Electric Aircraft (MEA) initiative. The AMD is the winning project of the second annual DUS&T Achievement Award, which recognizes successful dual-use projects and honors the individuals in the military departments responsible for initiating and executing the projects. The AMD goal is to double the use of state-of-the-art power, with

[1] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.

electric actuation efficiency greater than 80 percent. For an advanced future fighter, this would save 750 to 1,000 pounds. The AMD (via MEA) supports using electric power directly for current hydraulic, pneumatic, or mechanical aircraft subsystems for flight control actuation, Environmental Control Systems (ECS), and lubrication and fuel pumps. AMD also addresses other functions that can reduce maintenance costs and mitigate safety and environmental concerns. Global Express business jets are using the technology. Components developed as part of the AMD project will be used in future regional and business jets, with a 10-year projected commercial delivery of 4,000 units. The National Aeronautics and Space Administration (NASA) is considering using this technology in the Space Shuttle Upgrade Program.

Affordable Antenna for Weapon System Delivery and Cellular Communications[2]
Raytheon Systems Company is developing an antenna that will cost approximately 90 percent less than the current antenna used for weapon systems delivery. The new antenna will maintain or improve on the size, weight, and performance of present antennas. The technology being used will be scaleable for commercial cellular communications.

The project will result in an affordable airborne antenna that is as capable as current antennas but more reliable. In addition, the antenna can be assembled in 15 minutes. More than 2,000 of the commercial versions of the antenna have been sold for use in telecommunications.

Commercial Active Braking System for Medium-Duty Wheeled Vehicles[3]
Continental Teves is developing an Anti-lock Braking System (ABS) with low-speed traction control for the Army's High Mobility Multipurpose Wheeled Vehicle (HMMWV) and medium-size commercial trucks. The anticipation was that the braking system designed under this program would have commercial sales of at least 80,000 units per year and, because the special military requirements were considered during design, it will meet the HMMWV requirements with no major modifications.

Besides the obvious benefits of improved braking and safety, the most significant benefit of the program is access to a commercial product for meeting a military requirement at a reduced cost. The ABS developed under this program will be produced on the same line as Continental's commercial ABS and will cost the Army approximately $500 per copy. The cost of an ABS developed exclusively for the HMMWV, without a commercial base, is estimated at approximately $2,200.

This program used the OT authority granted DoD for its agreement with Teves, a non-defense-oriented commercial firm.

Commercial Radiation-Tolerant Deep Submicron Microelectronics[4]
The National Semiconductor Corporation (NSC) will establish a radiation-tolerant option for its commercial fabrication line to provide low-cost, commercial, radiation-tolerant electronics to

[2] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 20 November 2003, at http://www.dtic.mil/dust/news/ant.htm.
[3] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 20 November 2003, at http://www.dtic.mil/dust/news/abs.htm.
[4] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 20 November 2003, at http://www.dtic.mil/dust/news/submicro.htm.

military and commercial markets. This project will leapfrog current two-generation radiation-tolerant technology to equal the state-of-the-art for non-radiation-tolerant commercial parts.

The cost of devices fabricated as a result of this project will be reduced at least 50 to 70 percent from lines specifically designed for producing radiation-hard electronics. These savings result from the economies of scale present in a commercial production facility. In addition, the devices will add functionality not previously available, at low-power dissipation and increased performance.

This program used the OT authority granted DoD for its agreement with NSC.

Efficient Multijunction Solar Cell[5]

The efficient multijunction solar cell was a nominee for the Second Annual DUS&T Achievement Award. This AFRL Advanced Space Power Generation Group program was conceived and implemented to increase solar-cell efficiency to meet the continued growth in power requirements of large and small DoD satellites, as well as the growth in power demand of commercial satellites. The more efficient triple-junction solar cell developed through this project for military and commercial applications will generate more power for the size of the solar arrays, or smaller arrays for a power budget. The new cells enable the flexibility of increasing payload mass and power budgets, reducing launch cost by reducing power system array mass, reducing LCCs, and will enable scaling up the power system for both military and commercial applications.

Electric-Powered Actuators for Aircraft Flight-Control Surfaces[6]

The AFRL and Hamilton Sundstrand are collaborating on a dual-use program for developing an Electromechanical Actuator (EMA) to exploit the benefits of electric power technology. The focus of the program is the motor drive, which includes the controller, inverter, and motor used to control the EMA.

The technology will be an AMD featuring high-power density and efficiency, which will be used to control a 270-volt DC EMA. The EMA is compatible with the requirements of a spoiler for a typical transport aircraft. The increased power density of the AMD is attractive to commercial users because reductions in weight result in improved fuel efficiency and extended range, which translate to considerable cost savings.

Enhanced Crash Protection for Occupants of Heavy Tactical Vehicles (HTVs): Inflatable Restraint System and Crew Cab Delethalization Techniques[7]

This project was a nominee for the Second Annual DUS&T Achievement Award. The goal of this Army Tank-Automotive and Armaments Command (TACOM), National Automotive Center (NAC) project has been to recommend safety products and cab design changes for the Army's HTVs to reduce head, neck, and torso injuries and fatalities during crashes. Products developed, tested, and recommended include inflatable devices that are hidden in the shoulder belt and above the vehicle door until the crash sensor inflates them. Using these devices will reduce the

[5] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.
[6] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/electric.htm.
[7] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.

number of injuries and deaths caused by accidents. This technology, jointly developed by Delphi Automotive Systems and Simula, Inc., has resulted in contracts totaling $50 million annually.

This program used the OT authority granted DoD for its agreement with Simula, Inc. This technology also has been incorporated into at least one model of a luxury automobile.

Freeform Manufacturing of Spares Using Lasforming[8]

The Boeing Company, together with AeroMet Corporation and Virginia Polytechnic Institute and State University, will demonstrate Lasforming as a viable freeform method for producing new and difficult-to-get titanium spare parts for aircraft and ships at low cost. Lasforming uses 3-D graphical models to build up parts in layers from metal powders that are melted and fully consolidated with a laser.

The project will result in a cost-effective process for manufacturing spare titanium parts, with 30 percent cost savings of fabricated parts, and a 75 percent reduction in delivery time. Three F/A-18 E/F wing components have been selected as candidates for demonstrating the process. Commercial potential is a fabrication method for small manufactured lot sizes of original or replacement aerospace components.

This program used the OT authority granted DoD for its agreement with the project team.

Future Air Navigation and Traffic-Avoidance Solution through Integrated Communications, Navigation, and Surveillance (CNS) [9]

Rockwell Collins, Inc., a firm that does both defense and non-defense work, is developing and adapting commercial-grade hardware and software products for upgrading existing fighter aircraft CNS capabilities for air traffic control compliance while minimizing installation effects. The primary targets for the technology are tactical fighter aircraft and small commercial aviation aircraft that have size and weight constraints.

The technology benefits both cost and performance. The programmable hardware being developed will be a means for upgrading tactical fighter aircraft and smaller aviation aircraft by using the same software that is used for the commercial and large-body aircraft.

Upgrade costs will, therefore, be minimized by the many uses of the software. The software also will help in complying with future air traffic control requirements rapidly as they evolve.

High Brightness Emissive Miniature Displays[10]

An individual from the AFRL's Visual Display Systems Branch was recognized for this project, which was a runner-up for the Second Annual DUS&T Achievement Award. The project developed the first full-color, high-luminance, monochrome active-matrix organic light-emitting diode display. The characteristics of the display make it ideal for helmet display optics, and it was designated display technology of 2000 by the Society for Information Display and *Information Display Magazine*. The technology is expected to meet all military needs for helmet-

[8] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/ laser.htm.
[9] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/ cns.htm.
[10] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.

mounted displays and was selected for several Air Force and Army helmet programs, including the Joint Strike Fighter (JSF) program. The Army's Land Warrior program will require about 3,000 units per year over the next 10 years. The low-cost and low-power consumption rates also make this display technology ideal for commercial applications. eMagin Corporation (the contractor for this project) has shipped more than 20 evaluation kits to customers, and its microdisplay is considered the best on the market. The technology is already finding applications in cell phones, computer-connected eyeglass displays, and head-mounted instrumentation displays. Future applications include medicine, computer games, and video.

Hybrid-Electrical Family of Medium Tactical Vehicles (FMTV)[11]
Lockheed Martin Control Systems (LMCS) is exploring using a series hybrid propulsion system on a military 5-ton truck. The new HybriDrive system will be integrated and demonstrated on an M1086. This is a 5-ton-payload cargo-body variant of the FMTV.

Developing and incorporating a hybrid electrical propulsion system into the FMTV will result in significant enhancements to the vehicles' performance and considerable financial benefits to the Army. Vehicle performance will be enhanced with faster acceleration, improved traction, and potential for generating electric power in the field without using auxiliary power units or towed generators. Near-term applications include mobile missile launchers and radar. The new smaller and lighter components also will be used in transit buses and Class 5-7 vehicles. These components will be used on metropolitan transit buses in a major U.S. city.

This program used the OT authority granted DoD for its agreement with LMCS.

Improved Chemical Heater for Field Rations[12]
TDA Research, Inc., is a small business investigating safer and less costly alternatives to the Flameless Ration Heater (FRH) used to heat ready-to-eat meals. The program develops a product that combines suitable heat characteristics and long shelf life with improved safety and environmental qualities that can be manufactured economically. The Army and TDA Research are working with potential producers and users to facilitate transitioning the technology to the field. Unlike the current FRHs, which drew little commercial interest because of safety concerns, the new technology has significant commercial market potential.

The estimate is that the product will cost 6 cents per heater less than the FRHs for initial procurement and save the military approximately $1.8 million per year. Moreover, because the product is safer than the current FRH and has improved environmental characteristics, the potential life-cycle savings will far exceed the initial procurement savings. These improvements in performance and cost will expand the commercial use of the heaters for camping, schools, and the workplace. The broader commercial acceptance will further reduce unit costs.

This program used the OT authority granted DoD for its agreement with TDA Research.

[11] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/fmtv.htm.
[12] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/food.htm.

Knowledge-Access Portal Technology for Medium Brigade and Command Post XXI Decision Makers and Other Knowledge Warriors[13]

A nominee for the Second Annual DUS&T Achievement Award, this Army Communications-Electronics Command (CECOM) project had the objectives of developing, demonstrating, and transitioning innovative knowledge-access portal technologies for improved "cognitive readiness." In addition, the project bettered knowledge-based decision making for the brigade combat team, Command Post XXI staff, and knowledge warriors at reduced cost. Four technologies are combined: case-based planning, context-driven reachback and search, integrated plan execution and adaptation, and process-aware collaboration. Benefits include superior cognitive readiness, greater mutual awareness, the ability to operate in the opposition's decision loop, and reduced risk in planning and executing missions. Commercial applications include customer relationship management, business intelligence, strategic planning, and collaborative enterprise-complex project management.

Navy EarthMap Observer (NEMO)[14]

Earth Search Sciences, Inc., (ESSI) is a leading provider of commercial remote-sensing services. The project is developing a dual-use, space-based system for collecting broad-area Hyperspectral Imagery (HSI) to characterize land and sea environments for naval forces and commercial users.

By using HSI, ESSI will have a means of characterizing littoral battlespace environments and developing littoral models, e.g., detailed bathymetry, water clarity. The NEMO will support U.S. forces with real-time on-board processing and demonstration of a tactical downlink of hyper-spectral data directly from spacecraft to the field. For the commercial user, this project will provide hyperspectral and panchromatic imaging data for applications, including land-use management, agriculture, forestry, environmental monitoring, geology, mineral exploration, and hydrology.

This program used the OT authority granted DoD for a portion of this program.

Next-Generation Transparency[15]

The Boeing Corporation is working with Delta Tooling Company, Ensign-Bickford Company, EnviroTech Molded Products, Pilkington Aerospace, and the University of Dayton Research Institute to use injection-molded frameless transparency technology for advanced strike aircraft. The group will design, manufacture, and qualify in flight, fully integrated injection-molded frameless transparencies.

The technology will be applicable to manned and unmanned aircraft systems requiring aircrew- or sensor-transparency subsystems with critical structural and optical requirements. The anticipation is that the technology will be used in the JSF. A variety of potential commercial applications for reducing cost and improving safety are foreseen. These applications include window systems for aircraft and helicopters, automotive windows, medical and computer equipment, and transparent roof and floor panels for earth-moving machines.

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[13] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.
[14] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/nemo.htm.
[15] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/nexgen.htm.

Optical Character Recognition (OCR)[16]
Applications Tech, Inc., a small commercial business, is developing a highly accurate OCR system for Arabic and Persian script to replace the inadequate Commercial-Off-The-Shelf (COTS) systems being used. The technology has already been transitioned to the Counter Intelligence/Human Intelligence ACTD project. Applications Tech has committed funds for developing commercial applications for the technology.

The product will improve the Army's ability to collect and analyze intelligence from foreign language documents in the low-quality form that is typically found in the field by eliminating the gross inaccuracies of the COTS OCR being used. This enhanced capability will improve translations, archiving, summarization, and information retrieval — giving troops in the field the ability to quickly react to intelligence information. The technology is already being used as a prototype in Bosnia for document filtering and triage. The commercial market for multilingual OCR is growing, with special interest in documents from the Arabic world, where electronically-represented text is relatively recent and original documents must be scanned and converted.

This program used the OT authority granted DoD for its agreement with Applications Tech, a non-defense-oriented small commercial firm.

Pulsed Electric Fields (PEF) for Sterilization[17]
This project, a nominee for the Second Annual DUS&T Achievement Award, is part of the U.S. Army Natick Soldier Center DoD Combat Feeding Program. The objectives were to use PEF technology for military and commercial food products to inactivate microorganisms that adversely affect product quality, and to verify technical and economic viability. PEF technology could improve the quality and variety of field rations and commercial foods, support extreme shelf-life requirements (that normal commercial processing and packaging cannot), support future battlefield effects via PEF-treated specialty foods with performance-enhancing food ingredients, and help meet the goals of flexible logistics for the future. The project verified the technical and economic viability of the technology. Using the technology in the greater-than-$400-million-per-year commercial markets for acid foods (e.g., orange juice) and fresh tomato products will provide extended-shelf-life products and help reduce military costs.

Renewal of Legacy Software Systems[18]
CPU Technology, Inc., is demonstrating the feasibility of replacing aging or obsolete processors with hardware emulators that can execute legacy software in real time. The ability to mimic numerous processor personalities on a single chip will allow reusing software between platforms. This project will improve the ability to incrementally upgrade platforms and enables continued use of proven legacy software.

The ability to reuse existing software while simultaneously permitting growth to higher speed or the ability to develop new software using commercially available support tools for Higher-Order Languages (HOLs) promises great savings in dealing with hardware obsolescence while improving system performance. The new technology will allow continued use of legacy software

[16] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/ocr.htm.
[17] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.
[18] DTIC, *Success Stories*, DUS&T Program Web site. Accessed 12 December 2003, at http://www.dtic.mil/dust/news/legacy.htm.

while improving speed and performance. The same potential benefits exist in commercial software for the aviation industry, communications, commercial computer systems, and space systems.

Robust Image Authentication and Discovery[19]

This AFRL Information Directorate project, a nominee for the Second Annual DUS&T Achievement Award, was initiated to further the progress of data-embedding technology by using image-data embedding, watermarking, and steganography (covert communication). This project resulted in a prototype digital watermarking camera, demonstration and delivery of image watermarking techniques that withstand image manipulation, development of secure watermarks for images, and demonstration of steganography techniques. These technologies enable images to contain value-added information throughout their life, and support information assurance requirements for detecting image tampering. The commercial applications are for law enforcement and prosecution by validating images of crime scenes, verifying driver's licenses and identification cards, protecting Intellectual Property Rights (IPRs), and watermarking custom postage stamps and identification cards.

Smart Starting, Lighting, and Ignition Battery[20]

This Army TACOM Project, a nominee for the Second Annual DUS&T Achievement Award, integrated a control and reporting capability into batteries. The technology will report the state of charge, history, state of health, and critical operating parameters to a database for processing. This will result in better power and energy management, maintenance support, load leveling, and improved system reliability. This technology could double the life expectancy of conventional batteries. The commercial truck industry considers the smart battery a "must have" utility because of the known costs of a truck failing to start. The technology can be transferred to fuel cells and all battery chemistries, and the battery packs for electric and hybrid vehicles.

This program used the OT authority granted DoD.

Thermal Sprayed Nanostructural Coatings for Dual-Use Applications[21]

Two individuals from the Navy's Office of Naval Research (ONR) shared the Second Annual DUS&T Achievement Award for this project. The project developed a highly wear- and corrosion-resistant ceramic composite coating that can be applied using existing industrial equipment and standard thermal spray processes. The primary benefit of the technology is a reduction in LCCs by increasing corrosion resistance and wear protection. In addition, thermal spray coatings are superior to hard-chrome plating and are about 60 percent less expensive because of less cost for complying with environmental regulations. Navy applications for this technology are well under way, including air intake and exhaust valves for submarines (expected to save $400,000 per ship, or $20 million over the next 10 years), and USS *George Washington's* electric motor and oil pump shafts. The technology also will be used for mine-countermeasure ships' main propulsion shafts (saving $1 million per year, per ship). These applications demonstrate the technology's military benefits for reduced TOCs for submarines, surface ships, and aircraft. The technology also is transitioning into commercial products. Warren Pump is using the technology to manufacture screw pump rotors for commercial gas turbines and fuel

[19] DTIC, *2nd Annual DUS&T Award Brochure*, February 2002.
[20] *Ibid*.
[21] *Ibid*.

feed pumps, as well as water pan rolls for the printing industry. Inframat (the contractor for the project) has formed a new company, Nanopac, to pursue new opportunities.

This program used the OT authority granted DoD.

UL3 Imaging Infrared Camera[22]

Three individuals from the Army's Night Vision and Electronic Sensors Directorate (NVESD) were recognized for this project, which was a runner-up for the Second Annual DUS&T Achievement Award. This project designed, fabricated, and tested a low-cost, low-power, uncooled infrared camera that weighs approximately one and three quarter ounces and is only two cubic inches. The camera's size and reduced cost make it ideally suited for mounting on a helmet or rifle, as a battle-space sensor, and for micro air vehicles. The 10th Mountain Division is testing the camera in an UAV. The technology developed under this program has generated the warrior extended battlefield S&T objective and a follow-on ATD, which will result in this technology's use in the field. The camera also has tremendous commercial potential. The Omega, the commercial name for the UL3, is the enabling technology for a new generation of handheld fire-fighting cameras. A total of 1,200 units was delivered in 2002. In addition, Indigo (the contractor for this project) and Autolite are introducing a new night-driving system in 2003, which is based on the Omega camera. The units are expected to cost $500, and projected five-year sales are $400 million. These commercial sales are essential to making the camera more affordable for military applications.

This program used the OT authority granted DoD.

Very-High-Power Electronic Building Blocks (PEBB)[23]

This ONR project developed a new family of products for electric power and future shipboard electric power distribution, electric propulsion, and electromagnetic launch and recovery systems. The project was a nominee for the Second Annual DUS&T Achievement Award. The very-high-PEBB concept incorporates progressive integration of power drivers, gate drives, snubbers, and other components into functional blocks for reduced costs, losses, weight, and size. Commercial applications in automotive, aerospace, industrial motor drives, and utilities will help reduce unit costs. The technology developed through this project will provide reliable power and energy storage to support the electric warships' and combat vehicles' future naval capability. The technology has resulted in $41 million of booked sales for PEBB-based systems and products, and some $34 million in sales of other directly dependent technologies.

This program used the OT authority granted DoD.

Additional DUS&T Success Stories

For more stories of successful DUS&T programs, see Appendix A of the October 2001 DDR&E guidebook *Dual Use Science and Technology Process: Why Should Your Program Be Involved? What Strategies Do You Need to Be Successful?*

[22] *Ibid*.
[23] *Ibid*.

SMALL BUSINESS INNOVATION RESEARCH (SBIR)[24]

Active Technologies, Inc.

Under the DARPA SBIR program, Active Technologies, Inc., developed a high-output, small-size alternator that led to development of the "Lightning Charger" — a highly successful commercial product with important military applications. The Lightning Charger is an engine-driven alternator that weighs 18 pounds and generates 900 watts of power — roughly one-third the weight and twice the power of previous alternators. The Lightning Charger is used for powering such equipment as emergency lights and refrigerators, and to start vehicles. In 1994, the Lightning Charger was featured in *Popular Science* as one of the best new products of the year. Active Technologies has been acquired by Coleman Powermate, which sells the Lightning Charger to consumers through major home appliance stores.

This technology has yielded important military applications. Military customers include the Army, which uses it to start tank engines when the batteries have died. The Army is also funding the development of a follow-on product based on this technology — a general-purpose, man-portable generator that soldiers will carry in the field for powering communications, hospitals, and equipment.

Advanced Technology Materials, Inc. (ATMI)

ATMI has leveraged several SBIR awards, to grow from four employees in 1987 with no revenues to more than 400 employees today and $125 million in annual revenues. Two-thirds of the revenues are from commercial markets; one-third is from DoD or defense contractors. Among its SBIR successes, ATMI has commercialized the results of an SBIR project with MDA that enabled fabricating a device for delivering ultra-pure materials to semiconductor thin-film reactors. The device is used in Naval laboratories to prepare ultra-sensitive infrared sensors, and by Intel, Motorola, AT&T, and IBM in their semiconductor plants around the world. Another of ATMI's SBIR-developed technologies is the gas source delivery system, which makes storing hazardous gases used in semiconductor manufacturing at below atmospheric pressure possible, significantly improving the safety of gas storage and increasing the capacity of each storage cylinder by a factor of five. This technology has captured 10 percent of the world market; annual sales are now $30 million and have been expanding by 50 percent each year.

American Xtal Technology, Inc. (AXT)

Under the DARPA SBIR program, AXT developed a "vertical gradient freeze" technology for producing Gallium Arsenide (GaAs) wafers — a critical component of integrated circuits used in the communications, satellite, radar, and defense weapons industries. This technology results in chemically and electrically uniform GaAs wafers with one to two orders of magnitude (fewer defects than the alternative production technology). Further development funds from private-sector partners, as well as DoD's Title III program, moved this technology from prototype to commercial-scale production.

On the basis of this technology, AXT has become the leading domestic manufacturer of GaAs wafers for optical and electronic applications, with customers that include TRW, Hewlett-Packard, Lockheed Martin, and many universities and government laboratories. AXT's annual sales have grown from $500,000 in 1990 to approximately $40 million. In addition, AXT has captured approximately 15 percent of the world market in GaAs wafers and has created nearly

[24] The success stories in this section were published on the DoD SBIR/STTR Fast Track Web site at http://www.acq.osd.mil/sadbu/sbir/success/index.htm. Accessed 12 December 2003.

250 new high-tech jobs. Approximately 70 percent of AXT's sales are to DoD or its prime contractors.

Arroyo Optics, Inc.
Under the DARPA and Missile Defense Agency (MDA) SBIR programs, Arroyo Optics developed a technology that enables all-optical routing of communication signals from one fiber-optic cable to another. This technology has major advantages in cost and performance over existing technologies, which require that all of the optical signals in the first cable be converted to electronic signals and then back to optical signals when routing a signal from one cable to another. This technology reduces the number of signals that need to be converted by an average of 70 percent and requires far less conversion equipment. The result is significantly less signal degradation, lower cost, and ultimately, higher-performing, less-expensive communications for commercial and military customers.

Arroyo obtained approximately $500,000 in funding from "angel investors" to match its Phase II SBIR awards in 1996. The company has since raised an additional $26 million in Venture Capital (VC) and is building a production facility, with initial production orders to begin by the end of this year. Sales are projected to exceed $100 million per year by 2003.

Autonomous Technologies Corporation
Under the MDA SBIR program, Autonomous Technologies Corporation developed a laser-radar tracking technology with major military and commercial applications. The military use is in ballistic missile targeting; the commercial use is in ophthalmic laser surgery. During laser eye surgery, this technology enables the laser to automatically track tiny, rapid, involuntary eye movements and has demonstrated far superior performance for patients in a market with multibillion dollar potential. Autonomous, which began as a start-up company under SBIR in 1991, raised $20 million in a 1995 initial public offering and formed a strategic alliance with CIBA Vision for co-promoting its technology. In May 1999, Autonomous was acquired by laser manufacturer Summit Technology, Inc. At the time of the acquisition, Autonomous' stock was valued at $154 million. In 1999, the Food and Drug Administration (FDA) approved the technology for use in surgery to correct near-sightedness and astigmatism.

Digital System Resources, Inc. (DSR)
Under the Navy SBIR program, DSR developed a new technology — the Multipurpose Processor (MPP) — that has had a major effect on the capabilities of the U.S. submarine fleet. The MPP is a submarine sonar processor based on COTS technology that is used to determine the location of submarines and ships. The MPP replaces existing military-specific processors, providing 200 times the computing power at a fraction of the cost. In 1994, the Navy awarded DSR a $40 million contract to build three Engineering Development Models (EDMs) of the MPP. Subsequently, the Navy decided to use V1.0 C-16, the MPP technology to upgrade the sonar equipment on most Navy submarines (SSN 688, 688I, and SSBN 726 [*Trident*] submarines) and to use it on the new attack submarines as the principal acoustic signal processor.

HNC Software
Under the DoD SBIR program, HNC Software (originally known as Hecht-Nielson Neurocomputer Corporation) developed a number of technologies that have greatly improved the speed and accuracy of target recognition for Army and Navy customers and have had major commercial applications, including a new class of application software known as Predictive

Software Solutions (PSS). HNC's Falcon™ System, which embodies the PSS technology, is now widely used in the bankcard industry to uncover credit card fraud in real time to protect financial institutions and consumers. Falcon learns patterns and relationships in data, accurately detecting unusual purchasing behavior at the transaction level. Falcon technology has been applied to detect Medicare and Medicaid fraud, and to detect and manage Internet credit card fraud for online merchants and consumers. HNC's customers include Sears, Fireman's Fund, Brooks Brothers, The Home Shopping Network, and Sprint Communications. HNC's technologies also are used in Navy sonar recognition systems, enabling submarines to process sonar signals and detect objects in an underwater environment more efficiently.

HNC went public in 1995, and is a leading provider of complete predictive customer relationship management solutions for service industries. Red Herring rated HNC as one of the top 100 public companies in 1998, and in 1999 *Fortune* magazine listed HNC as one of the 100 fastest growing companies. Total sales from HNC's SBIR-developed technologies now exceed $230 million (1988 through 1998).

II-VI, Inc.
II-VI developed a process under a DoD SBIR contract that substantially reduced the defects in optical coatings used with high-energy lasers. The technology was so successful that it was commercialized during, and was in full operation by the end of Phase II. Since 1988, the technology has generated approximately $30 million in revenue; 20 to 30 percent of the sales have been to the DoD or defense contractors, including Hughes Aircraft, Raytheon, Martin-Marietta (now Lockheed Martin), Texas Instruments, and Westinghouse. II-VI has developed a number of other commercially successful technologies by participating in SBIR, and sales from its SBIR-related product lines total more than $63 million since 1987.

Integrated Systems, Inc.
Under the DoD SBIR program, Integrated Systems developed a technology for the efficient writing of embedded software, including software for a robot that loads munitions, which had important spin-offs in the automobile industry. Cumulative sales from the SBIR-developed technology have exceeded $100 million, about 15 to 20 percent of which are from sales to the DoD or prime contractors. Integrated Systems, which began as a start-up company, is now publicly traded on the NASDAQ with a market valuation of just under $400 million.

Integrated Systems' embedded software is used in a variety of commercial applications, including the gas pumps that enable customers to pay at the pump with a credit card. Among its many defense applications, Integrated Systems' technology was used to develop all of the software for the DC-X experimental launch vehicle. According to the prime contractor (McDonnell Douglas, now Boeing), the software reduced both the cost and the time of software development by more than 50 percent. DC-X was the first launch-vehicle project in which software was developed ahead of hardware, and within schedule and budget.

Irvine Sensors Corporation, Inc.
Irvine Sensors Corporation developed a chip-stacking technology using funding from NASA's SBIR program and a small contract from the Air Force. The technology enables 4 to 8 computer or memory chips to be glued into a small stack in the footprint of a single chip. After Phase II, IBM and Irvine Sensors invested more than $20 million to develop the technology into a manufacturable product. About half of the $10 million annual sales are to DoD or defense

contractors, and the rest are to private-sector customers. Sales are expected to increase significantly.

M. Technologies, Inc.
M. Technologies developed a "smart bomb rack" under the Navy and Air Force SBIR programs and was awarded a $26 million production contract from the Air Force to produce the rack for the F-16/Block 50 aircraft (approximately 350 planes). The smart bomb rack doubles the number of smart bombs that the aircraft can carry and deploy. Smart bombs use the Global Positioning System (GPS) to hit their targets accurately.

Magnetic Imaging Technologies, Inc.
Under the Air Force STTR program, Magnetic Imaging Technologies has developed a Magnetic Resonance Imaging (MRI) technology, originated by a Princeton University physics professor, which creates images based on gas rather than liquid (as under the existing MRI technology). Thus, for the first time, this technology enables clear imaging of the ventilation in a patient's lungs — a major breakthrough in diagnosing lung diseases and disorders, including, for DoD, the exposure of soldiers to chemical weapons during battle.

The company initially attracted more than $1 million in outside investment to add to the DoD's funding of $600,000, including a cash investment from the individual who headed General Electric's development of the initial MRI technology 20 years ago. The company has since attracted more than $15 million in additional private investment, and was recently acquired by Nycomed Amersham, Inc., a world leader in diagnostic imaging. The technology is undergoing clinical trials and awaits final approval by the FDA. The company's market size exceeds $100 million.

Ophir Corporation
An infrared-absorption hygrometer, developed by Ophir Corporation under the Army's SBIR program for assessing atmospheric conditions before firing artillery, found its primary military application in the Air Force's fleet of B-2 bombers. Specifically, this technology led to developing a "pilot alert" system, which, as installed in the B-2, warns the pilot if the plane is about to produce a trail of condensation that could be detected by enemy radar. Sales to date to both the Air Force and commercial customers exceed $27 million.

ParaSoft Corporation
ParaSoft Corporation developed a software debugging program under the MDA SBIR program that has broad application for DoD, major defense contractors, and the private sector. ParaSoft's lead product, Insure++, highlights possible bugs in lines of software and gives the author an opportunity to correct them. The software is used by most major developers of commercial software (e.g., IBM, Lotus, and Microsoft) and organizations that develop software for in-house use, e.g., Naval Research Lab, Lockheed Martin, Hughes Aircraft, Boeing, Pratt-Whitney, the Internal Revenue Service (IRS), and the U.S. Postal Service (USPS). As of March 1999, Insure++ had generated more than $30 million in sales. ParaSoft has grown from three employees in the early 1990s, to 120 employees, and continues to grow rapidly.

Power Spectra, Inc.
Under a DoD SBIR contract, Power Spectra developed and tested a bulk avalanche semiconductor switch activated by a laser. The switch can deliver 15 kilovolts in less than a

nanosecond and can achieve this in excess of a billion times during its life. Boeing Corp. was the principal source of financing after Phase II, supplying $21 million since 1989 for developing the technology into a product with broad commercial and military applications — primarily ultra-wide-band radars for penetrating foliage and the earth. The technology has since become classified, and the primary customer is the military electronic warfare community. Cumulative sales revenues from the switch are roughly $12 million: $9 million to the DoD and $3 million to the private sector.

Savi Technology, Inc.
Savi Technology recently developed the industry's first radio computer tag, the "SaviTag," using a combination of Navy SBIR funding and private Venture Capital (VC). The SaviTag — a radio transceiver with an embedded microcomputer — can be attached to military cargo containers, or any other crate or container used for transport, and will track the container's location and contents automatically. The SaviTag was developed with just $2.5 million in SBIR funding (three awards) and has become a central element in the DoD's Total Asset Visibility (TAV) (the DoD effort to be able to pinpoint the location and content of every plane, ship, tank, and cargo container in transit around the world). Savi has received military contracts totaling more than $185 million, and DoD uses the SaviTag in a large segment of its logistical operations, including almost all shipments into Bosnia.

The SaviTag solves a very real problem for DoD. During *Desert Storm*, more than half of the 40,000 cargo containers shipped to the desert, including $2.7 billion worth of spare parts, went unused, according to a General Accounting Office (GAO) report. The Army has estimated that if an effective way of tracking the location and content of the cargo containers (e.g., the SaviTag) had existed at that time, DoD would have saved roughly $2 billion. The SaviTag already has resulted in major efficiencies in our logistical operations in Bosnia, although the savings have not been precisely estimated.

The SaviTag also has major applications in the private sector, particularly in the commercial trucking, rail, and shipping industries. Savi Technology's sales to the private sector are projected to be $20 million this year and are increasing rapidly.

Science Research Laboratory, Inc. (SRL)
Under four DoD and Department of Energy (DOE) SBIR awards between 1989 and 1993, SRL developed a cluster of solid-state pulsed power technologies that made excimer lasers, for the first time, a commercially viable tool for the Ultra Violet (UV) lithography used in writing current-generation integrated circuits onto computer chips. Specifically, these SBIR-developed technologies did the following:

- Eliminated missing laser pulses observed with the older ("thyration switch") technology, thereby stabilizing the laser power, improving dose control to the semiconductor wafer, and greatly improving chip yield; and

- Increased the lifespan of the laser driver by a factor of 100 and the lifetime of the laser head by a factor of 10 to 20, thereby reducing the annual maintenance costs of the laser from $250,000 to $50,000.

Because of these technologies, excimer lasers represent the state-of-the-art technology for writing circuits onto a chip. Using excimer lasers has enabled reducing the critical dimensions of the circuits from 0.35 microns to 0.25 microns with the existing KrF (Krypton Flouride) laser technology, and ultimately will lead to critical dimensions of 0.1 microns with the new ArF (Argon Flouride) laser technology. The result has been a significant increase in the computing power of virtually every military and commercial system developed in recent years.

SRL commercialized these technologies through a license to Cymer, Inc., which went public in 1996 on the basis of these technologies. Cymer now produces and sells approximately $200 million annually in lasers for Cannon, Nikon, and ASML.

Silicon Designs, Inc.
Under the Navy and MDA SBIR programs, Silicon Designs developed the "accelerometer" used in most DoD missile systems, including Patriot PAC-3, AIM-9X, ESSM (Evolved Sea Sparrow Missile), Hellfire 2, and Javelin. The accelerometer is a sensor that tells the missile to arm itself when it reaches a certain speed. This technology replaced a mechanical switch used in earlier missile systems, which was significantly less reliable and cost five times as much.

Silicon Design's accelerometer also is used in all new Ford and Chrysler automobiles produced in the United States. In the automobiles, it triggers the inflation of the airbags when the car decelerates abruptly during an accident. As in the missile systems, this technology replaced a mechanical switch, which was significantly less reliable, several times as expensive, and, unlike the accelerometer, could not be tailored to respond differently to different types of impacts.

Total sales of the accelerometer to DoD and commercial customers are $40 million per year. DoD's initial SBIR investment was just $1.2 million.

Taylor Devices, Inc.
A computer program developed by Taylor Devices under the Air Force's SBIR program for determining how the MX missile could be protected against different shocks (such as a nuclear bomb attack on a missile silo) is used in virtually every major defense system built in recent years, including the *Seawolf*-class submarine, *Los Angeles*-class submarine, *Aegis* cruiser, *Arleigh Burke* destroyer, B-2 bomber, *Tomahawk* missile, THAAD (Theater High Altitude Area Defense) missile, and M109 A-6 Paladin. For example, on the *Seawolf* submarines, the Navy used this technology to determine that a particular COTS isolator was the most cost-effective way of protecting the submarines against the shock of mine detonation and torpedoes, which resulted in millions of dollars in savings over using a much more expensive military-specific alternative. This technology also has had significant commercial applications protecting buildings in seismic risk areas, including the San Francisco Civic Center, against earthquake damage. Sales since 1992 exceed $29 million, of which roughly 75 percent have been to the private sector.

ViaSat, Inc.
Under the Air Force SBIR program, ViaSat developed a "demand assigned multiple access" networking technology that is now used for both military and commercial satellite communications. Subscribers equipped with this technology can access a satellite channel on demand — which means that each subscriber uses satellite resources only for the time they are communicating rather than setting up a dedicated channel (as was necessary under the previous

technology) for an extended period. The network can serve approximately 10 times as many users during a day. ViaSat's military sales and orders to date are approaching $90 million for subscriber and network control terminal equipment. Initial commercial sales (to AT&T, Hutchison, and others) are $7 million and increasing rapidly, with commercial satellite communication markets reaching into the hundreds of millions of dollars annually.

Vista Controls Corporation
Vista Controls Corporation developed an advanced electronic computing card through the SBIR program. The card is used in military tanks, helicopters, and training and simulation systems, as well as in commercial vehicles, such as railroad cars. Cumulative sales to DoD customers — including the Army, Air Force, and Marines, through such prime contractors as United Defense, General Dynamics, and Lockheed — total approximately $20 million. Cumulative sales to private-sector customers, including Union Switch and Signal, total about $5 million.

TECHNOLOGY TRANSFER

Although this Guide does not specifically discuss technology transfer,[25] we offer these success stories[26] because much of the technology that is transferred from government to industry later returns to the government as commercial products.

Applied Research Laboratory at the Pennsylvania State University
Technology transfer and deployment are principal missions of the Applied Research Laboratory at the Pennsylvania State University. The Laboratory champions the transfer of advanced technologies and manufacturing processes, in partnership with industry and Navy R&D centers, to acquisition programs and the fleet. The Laboratory's charter promotes transferring technology for economic competitiveness and supports congressional and DoD mandates for transferring federally funded technology to the commercial sector. Technology transfer projects range from assisting with implementing COTS technology for enhancing productivity, to implementing advanced technologies for developing new products or processes.

The Applied Research Laboratory at the Pennsylvania State University developed many technologies under federal projects and non-sponsored departmental research. The Laboratory's relationships with small companies; its teaming skills with government, industry, and academia; and its problem-solving focus, all have consistently led to transferring and deploying technology effectively. In addition, the Laboratory continues to expand and upgrade its facilities and develop new strategic government and commercial alliances. The Laboratory hosts national symposia, highlighting areas of technical expertise, and sponsors detailed hands-on workshops for transferring technology to government and industry.

Technology transfer is particularly concentrated on supporting economic development for industry in Pennsylvania. These efforts include transferring Navy, DoD, and other government-funded developed technology, and directly developing technical support and proposals; directly supporting contracts; and training and teaching continuing education. Industrial development programs take several forms. The Laboratory can work for other projects under a contract, or do the work itself under a contract to industry. Other forms of assistance include consortia programs and projects and state-funded efforts.

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[25] *Technology transfer* is the process of sharing knowledge gained in federal laboratories with the private sector, generally for encouraging new commercial markets and applications.
[26] Accessed in 12 December 2003 from the DTIC's "TechTransit" Web site at http://www.dtic.mil/techtransit.

State funding and assistance programs give the Laboratory the opportunity to work with small, entrepreneurial companies in ways that lead to developing thriving companies and new industries. One example is GEO-Form, a small, environmental engineering startup in Girard, PA. The Laboratory helped GEO-Form design and manufacture a biological reactor system prototype for municipal wastewater treatment to meet the Pennsylvania Department of Environmental Resources' certification trials. The result was an all-composite design that outperformed existing and competing systems many-fold, and met performance and cost requirements. Each component is produced by the most efficient available manufacturing process. The system is being installed at all highway rest stops in Pennsylvania, and the company is expanding worldwide.

The Laboratory's technology transfers and deployment have been successful in many technology areas, such as shearography, spectroscopy, turbine-blade stripping, laser cladding, spectro/paint characterization, fatigue amelioration, and welding of lightweight structures. Industrial success stories include laser cutting and welding of aluminum for automotive applications, laser cladding of struts for fabricating and repairing heavy equipment components, laser welding of medical equipment, laser cutting of bicycle frame components, development of lightweight composite frames for high-performance bicycles, and improvements in Laboratory centrifuges. Details of these and similar success stories are on the ManTech Program's Web site at http://www.dodmantech.com/successes/index.shtml and on the Applied Research Laboratory at Penn State's Web site at http://www.arl.psu.edu.

National Aeronautics and Space Administration (NASA)

Technology transfer always has been a major thrust for the NASA Centers. In the past, NASA's Marshall Space Flight Center (MSFC) focused its technology transfer resources on assisting industry and small businesses. The NASA field agents located industry problems and provided companies with as much as 40 hours of free technical assistance. However, such services eventually put a strain on MSFC's resources and detracted from the Center's primary mission. Inadequate resources were applied to partnerships for developing and deploying technology, managing intellectual property, licensing patents, transferring technology, and doing case studies about success stories. To better meet the needs of internal and external customers, MSFC restructured its technology transfer program in 1997.

The structure of the new technology transfer program was changed from a hierarchical, stovepipe framework with little communication or interaction among units to a flat organization with an integrated, cross-trained team. In addition, the Center shifted its primary focus away from gratuitous extension services and set up eight interdependent mission areas: Technology Development (TD); small business programs; new technology reporting; facilities commercialization; technology and software commercialization; technology deployment partnerships; national, regional, and local strategic alliances; and technology education and outreach projects for economic development. These areas give MSFC a more cost-effective, balanced portfolio of high-quality products and services. New objectives were identified to help U.S. industry become more globally competitive, specifically through national goals for the civilian space program and responsibilities of transferring NASA technology. Under this new approach, MSFC applied business principles to government technology transfer processes to gain efficiencies, improve performance, and align with mission requirements. The infusion of this strategy into NASA's traditional technology transfer mechanisms revitalized the overall program. As a result, numerous methods and agreements now exist for transferring NASA technology to the private sector, such as the following:

- **R&D Agreements:** Arrangements between NASA and private companies, for which the expenses of NASA facilities, personnel, equipment, technology, or capabilities are fully reimbursable, partially reimbursable, or non-reimbursable by the private companies.

- **Joint Research Agreements:** Arrangements that are jointly funded and undertaken by NASA and one or more private-sector companies.

- **SBIR Program and Small Business Technology Transfer (STTR) Contracts:** Programs designed to benefit small and disadvantaged businesses.

- **Cooperative Agreements, Grants, and Contracts:** Methods used to stimulate TD and commercialization. Many NASA technologies are available for licensing with flexible agreements and mutually beneficial exclusive and nonexclusive arrangements.

NASA uses different publications to highlight its technology transfer opportunities and success stories. *NASA Tech Briefs* is a monthly magazine that features technical articles about emerging technologies from the NASA centers. This magazine is published in hard copy and available electronically at http://www.nasatech.com.

Aerospace Technology is a bi-monthly news summary about how NASA technology is being used, and it covers the intricacies of actual technology transfer. This news summary is accessible at http://www.nctn.hq.nasa.gov. *NASA Spinoffs* is an annual compilation of success stories of NASA technology being used for improving medical, environmental, manufacturing, construction, transportation, safety, consumer, and computer products. This publication is available in hard copy and electronically at http://www.sti.nasa.gov/tto. Users who visit the Web site will find a searchable database for browsing technology transfer case studies. Additional information can be obtained directly from the MSFC Technology Transfer Office by visiting its Web site at http://www.nasasolutions.com, or by contacting the office at 256-544-6700.

Since implementing its new approach to technology transfer, MSFC has compiled success stories in all eight mission areas and has satisfied its customers, both internally and externally. Technology is transferred to all mission areas interactively and synergistically. During the past year, the number of patent licenses increased by 108 percent and the number of partnerships increased by 67 percent. The entire effort is contributing directly to U.S. national objectives for developing and commercializing space technology.

Chemical Biological Explosives Containment System (CBECS)

CBECS is a system designed for the containment and mitigation of chemical explosive terrorist devices and /or small munitions. The primary containment shelter is a pneumatic structure supporting a Kevlar tent with a filling sock for aqueous foam. CBECS is approximately 7 feet in diameter at the base and tapers to 4 feet in diameter at the top. Once inflated, it is designed to be placed over the offending terrorist device/munition and be filled with aqueous foam. This component will contain/mitigate approximately 70-100 percent of the blast over pressure, fireball, agent dissemination, and fragments of the device/munition. The secondary containment shelter is also an airframe, which is easily inflated and placed over the primary containment system. This secondary shelter measures 13 feet wide, by 10 feet long, by 8 feet high, and is designed to contain the residual effects, primarily escaping fragments and vapors/aerosols, from the primary system.

The Army's Edgewood Chemical Biological Center (ECBC) at Aberdeen Proving Grounds, MD, entered into a patent licensing agreement with Zumro, Inc., a commercial firm engaged in the safety industry, to market CBECS to commercial customers. Both the primary and secondary containment shelters of CBECS were jointly designed by the ECBC and Zumro, Inc., and were fabricated by Zumro. See http://www.dtic.mil/techtransit/ for more information.

GEL-COR, Specialized Ballistic Rubber Media

The Army's Engineer Research and Development Center's Geotechnical and Structures Laboratory (GSL) continued a 2002 Cooperative Research And Development Agreement (CRADA) with Super Trap, Inc. of Corona, CA, to improve existing firing range design and materials technology. The CRADA resulted in the joint invention of a specialized ballistic rubber media called GEL-COR. The CRADA granted Super Trap, Inc. a field of use license to GSL's patented shock absorbing concrete technology and provides for GSL's technical assistance in efforts to introduce the technology into construction of firing ranges. The new bullet traps will offer environmentally friendly and cost saving alternatives for both civilian and military firing ranges. In 2003, Super Trap, Inc. signed an exclusive field of use license with GSL to this joint invention of GEL-COR for firing range applications. Trap designs have been developed for use in both indoor and outdoor ranges. They will accommodate not only lead ammunition of small calibers, but also can handle lead alternatives such as tungsten or copper based-frangible rounds. See http://www.dtic.mil/techtransit/ for more information.

Aircraft Snow Removal System

For proper aerodynamics and flight safety snow and ice must be removed from airplanes prior to takeoff. Ethylene glycol and propylene glycol have been used to de-ice planes for many years. Runoff from both of these chemicals however, often times escapes into the ground water supply and can prove harmful to both humans and wildlife. Consequently the Environmental Protection Agency has established limits for these chemicals in ground water causing airport authorities to install multi-million dollar containment and treatment systems.

An Air Force Research Laboratory (AFRL) scientist developed a high efficiency forced air snow remover. The snow remover's design was perfected under a CRADA, allowing a number of patents and licenses to be awarded. There are now two commercial firms with competing forced air de-icing vehicles in the market place. These systems use compressed air to blow snow and ice off of aircraft surfaces and then spray a thin film of heated glycol on the flight surface to melt any residual ice. This new forced air technology is capable of readying an aircraft for flight without the use of any glycol. When glycol is required to complete the snow removal process the amount needed can be reduced to 30 percent of what would have been required using previous methods. See http://www.dtic.mil/techtransit/ for more information.

TECHNOLOGY TRANSITION

These success stories represent the efforts of recent ONR technology transition initiatives. Dr. James DeCorpo, Chief Technology Officer, ONR, provided the "2,000 CTO Successful Transition Stories" during an interview in Arlington, VA, on November 29, 2001.

Advanced SEAL Delivery System (ASDS) Propulsion Batteries
A two-year collaborative effort among six government organizations will transition the ASDS from current silver-zinc to lithium-ion battery propulsion. Using lithium-ion batteries increases mission capacity, provides 20 times more charge-discharge cycles, requires less maintenance, and allows more training time. Submarines carrying ASDS will avoid installing the nitrogen system required for silver-zinc batteries. This transition avoids $200 million in ASDS LCCs for batteries, maintenance, and submarine modifications.

All-Optical Towed Array
The state-of-the-art, all-optical towed array features improved cost, reliability, and performance and will be purchased for installation onboard SSN 688 and SSN 774 class submarines by FY04. This transition capitalizes on previous research by ONR and a proposal to the SBIR program, leading to a full System Development and Demonstration (SDD) program by Naval Sea Systems Command (NAVSEA) commencing in 2003.

Commercial Emulator for E-2C Group II Mission Computer
The Navy plans to operate Group II E-2C aircraft until approximately 2015. In 1999, Litton stopped supporting the L-304 mission computer (designed in the mid-1960s); all spare parts must now be obtained from stricken aircraft. An emulator has demonstrated executing the L-304 binary code on a COTS microprocessor. The emulator contains a virtual component environment that allows concurrent execution of legacy and modern C++ binary code, made possible by the additional throughput and memory of modern processors. This transition saves $140 million in costs over 15 years, saves 600 pounds of aircraft weight, and increases the Mean Time Between Failures (MTBFs) to more than 100 times that of the current computer.

Commercial Steel Certification for CVNX (Aircraft Carrier, Nuclear, Experimental)
The CVNX requires a service life allowance of 2,000 long tons to accommodate additional or heavier equipment, machinery, and configuration changes over the ship's initial 20 years of service life. An efficient way to achieve this weight allowance is to build the hull and other ship structures with commercially available (High-Strength Low-Alloy) HSLA-65 steel, which exhibits significantly greater strength and toughness than the steel presently used in hull structures of aircraft carriers. This transition enables certifying the HSLA-65 steel for use in the new CVNX and will allow all future Navy surface ships to be built with this modern steel.

Conformal Acoustic Velocity Sonar
The transition conducts a crucial at-sea patch test of piezoelectric array components with potential for reducing the weight and cost of submarine acoustic arrays. Using piezoelectric sensors in the conformal acoustic velocity sonar array will also be an evolution path for future submarine technology. When successful, it will save an estimated $8 million to $13 million per ship compared with the current lightweight wide aperture array.

Electronics Thermal Management for Advanced Amphibious Assault Vehicle (AAAV) and EA-6B
As electronic components become more compact and powerful, they generate more heat inside their racks, cabinets, and enclosures. This transition is the first military exploration of a new form of thermal management for these largely COTS components. It tests the new technology in the harsh environment of the AAAV to determine its maturity and effectiveness. The EA-6B program is monitoring the results for including the technology at Milestone C in 2003.

Environmentally Adaptive Algorithms for AN/SQQ-89 Sonar
Progress made by ONR in algorithm, software, and computing designs can now be transitioned into environmentally adaptive software for shallow-water operations using legacy deepwater sonar systems. This transition is an at-sea test of the concept using "clip-in" computers loaded with experimental shallow-water processing software. The at-sea testing will enable gathering operator feedback data and fine-tuning of the algorithms before including the software changes into the AN/SQQ-89 systems that will be procured after the tests. These tests are the first steps toward "adaptive control" of sonar pulses so they fully exploit existing water conditions, shallow or deep.

F/O Fibre Channel Data Backbone for F/A18 E/F
The original program plan to construct F/A-18 E/Fs with copper wire in the avionics backbone has been overtaken by newly available COTS fiber data transmission technology. Moving this technology into aircraft production not only reduces weight, volume, and TOC, but is also eliminates the need for modifying the backbone later to carry greater amounts of information. This transition reduces the cost of virtually every future avionics upgrade.

High-Performance Missile Batteries
New technology can provide lifetime batteries for the D-5 strategic missile system. This transition identifies the technical elements, demonstration, and engineering development needed to insert these high-performance, long-life batteries. This transition eliminates periodically replacing batteries throughout the missile's service life.

Intelligent Shock Mitigation and Isolation System (ISMIS) for LPD-17
Using a computer chip inside a sophisticated shock absorber to control its response, shocks experienced by electronics cabinets can be reduced to COTS levels. Each of the 12 ships of the LPD-17 Class will have more than 100 electronics cabinets that must be technologically refreshed periodically, largely with unmodified COTS components. The ISMIS technology will isolate these electronics cabinets from routine vibration and shock loads. ISMIS produces an "ultra-low g" environment that reduces or eliminates shock qualification testing for these cabinets and the components in them. This reduction in testing time and expense will facilitate quicker and less costly technology refresh, opening up more COTS options at substantially lower costs.

Marine Communication Interface Module (MCIM)
The MCIM is a common set of interface modules for HF/VHF/UHF bands. MCIM permits multiple legacy radios, and future digital radios when available, to connect with existing antennas and other system components without needing costly component-specific developments. The module also resolves co-site interference issues and efficient allocation of resources for voice, video, and data; and it decreases C2 platform costs, weight, and footprint. MCIM will be a standard C2 interface that will transition into upcoming block upgrade schedules for Marine Corps Unit Operation Center (UOC), LAV-C2, and UH-1 programs. It has potential application to various other naval platforms.

Precision Terrain-Aided Navigation
Recent advances in terrain-aided navigation make possible a highly accurate (and GPS-independent) navigation system for tactical *Tomahawk* cruise missiles. This transition has the technical elements, criteria, modeling and simulation, captive-carry flight tests, and other

technical information needed to bring this navigation system into *Tomahawk* System Development and Demonstration (SDD).

Reactive Material Warheads
Capitalizing on previous ONR and NAVSEA R&D investments, this transition is a short, intense, collaborative program for maturing reactive warhead material technology. The transition will generate a large (approximately 50 percent) increase in warhead lethality for three frontline missile systems against many types of targets.

Synthetic Aperture Sonar (SAS) for Long-Term Mine Reconnaissance System (LMRS) AN/BLQ-11
Rapid transition of SAS will provide ultra-classification (near ID) of mine-like objects at six times the range and three times the coverage rate of existing classification systems. The increased capability will improve the LMRS area coverage rate and extract additional features to improve classifying targets. In shallow water, SAS will enable classifying and potentially identifying actual mines among the hundreds of objects that may appear to be mines. This transition provides technology integration, modeling, analysis, and demonstrations needed to move SAS into producing the AN/BLQ-11 mine reconnaissance systems.

***Virginia*-Class Multi-Level Security**
This transition develops a COTS multi-level security system in software in a single tactical network aboard *Virginia*-class submarines, instead of adding hardware. The system will be developed in cooperation with the National Security Agency (NSA) and will provide multi-level security for data routing, network transmission, and information storage. This avoids the estimated $76.8 million for integration and design costs of a hardware solution.

Wave Division Multiplexing/Fiber-Optic Network for EA-6B
DoD relies on the Navy EA-6B for radar support missions. The existing mission equipment has been modified at least five times. Capturing recently developed wavelength division multiplexing technology from the commercial world, this transition will eliminate copper coaxial cables for RF and enable huge increases in data transfer rates, speed, and efficiency. At the same time, it will reduce weight, and give wider bandwidth and improved resistance to electronic attack.

APPENDIX D
TECHNOLOGY TRANSITION PLANNING AND PATHWAYS

The basic elements to consider when developing technology transition plans are summarized below. The general pathways to transitioning technology, shown in Figures D-1 and D-2, are ways in which technology can be provided to the DoD user.

TECHNOLOGY TRANSITION PLANS

No generic template is available for a successful technology transition plan. However, all technology transfer plans have elements in common. In general, technology transition plans should have the following elements:

- A Technology Development (TD) outline. This describes the TD pathway in detail.
- Expected outcomes of the project. The outcomes should be measurable and achievable "exit criteria."
- Funding strategy. The strategy names the resources to be provided according to source, amount, and timing.
- Schedule and milestones, including a transition or hand-off schedule.
- Identification of the "customer."
- Acquisition strategy and integration plan.
- Issues and risks — for cost, schedule, technical, manufacturability, sustainment.
- Signed "customer" and PM agreement for funding, schedule, and deliverables.
- "Customer" funding strategy for acquisition and fielding.
- Plan from multiple sources for using the technology and encouraging innovation in the program.

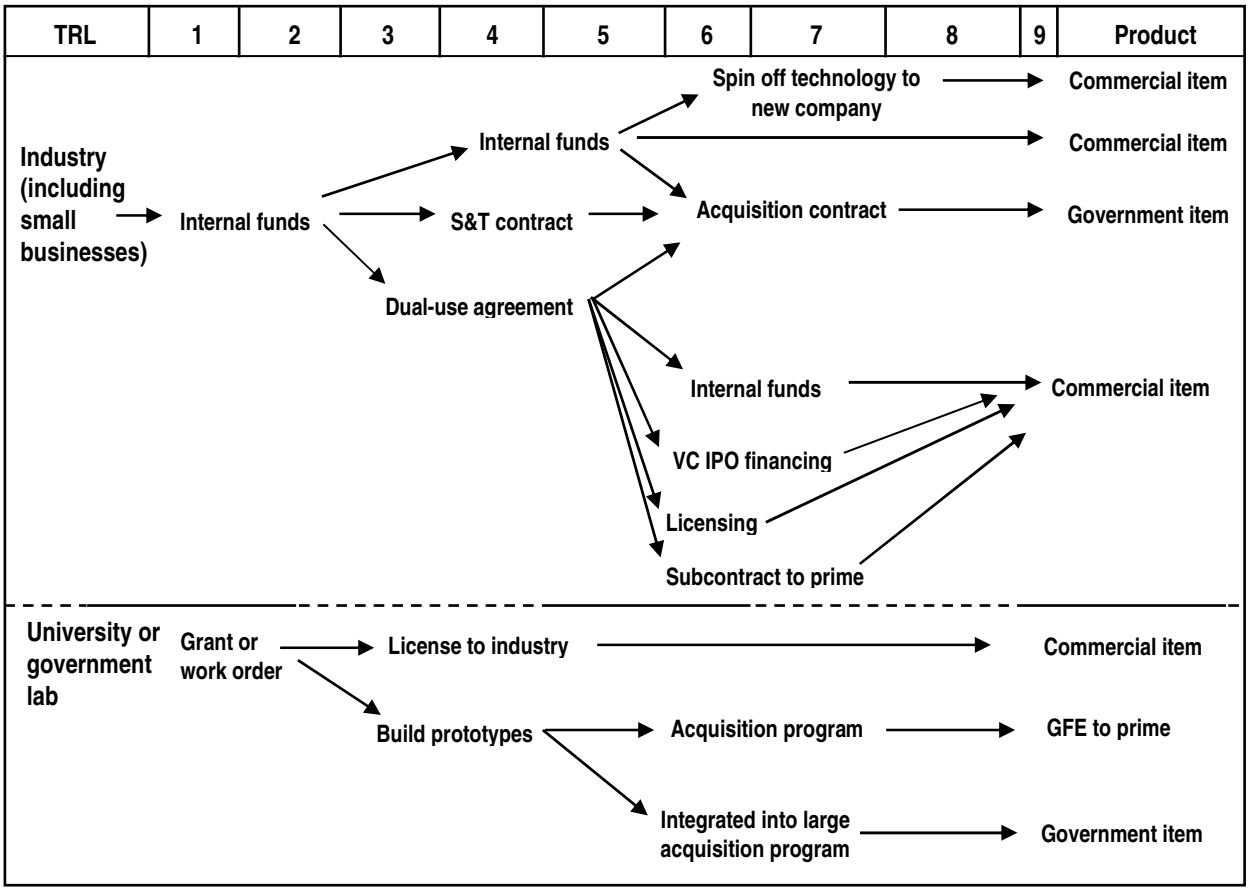


Figure D-1. Pathways to Transition

Note: "Pathways to transition" outlines the major funding decision points in relationship to DoD Technology Readiness Levels (TRLs). The TRLs shown are representative of typical decision points, but are not fixed. "Contract" means a contractual instrument appropriate for the situation, such as FAR Part 12, FAR Part 15, modifications (e.g., Value Engineering Change Proposals (VECPs)), or OTs.

The Technology Assessment and Transition Management (TATM) Process

Although there is no such thing as a "cookbook" approach to managing technology transition and there is no DoD 5000 prescribed template for Technology Transition Agreements, there are existing processes that might serve as "go-bys" for the acquisition and S&T communities. One such process is TATM. It is, as of this writing, largely a work in progress, but still provides insightful guidance and a possible pathway to managing technology transition.

The TATM process was developed in 2003 as a two-phased risk identification and management process intended for use at the PEO level and by individual acquisition PMs. The TATM process development was a collaborative effort between the Army's PEO Aviation; the Aviation and Missile Research, Development and Engineering Center; the Aviation user community at Fort Rucker, AL; and the Southern Regional campus of the Defense Acquisition University. The primary benefit of TATM is the linkage and synchronization it provides between system development programs and transitioning S&T projects. Although TATM was developed within the framework of the Army's Aviation community, its underlying methodologies are applicable and relevant across DoD.

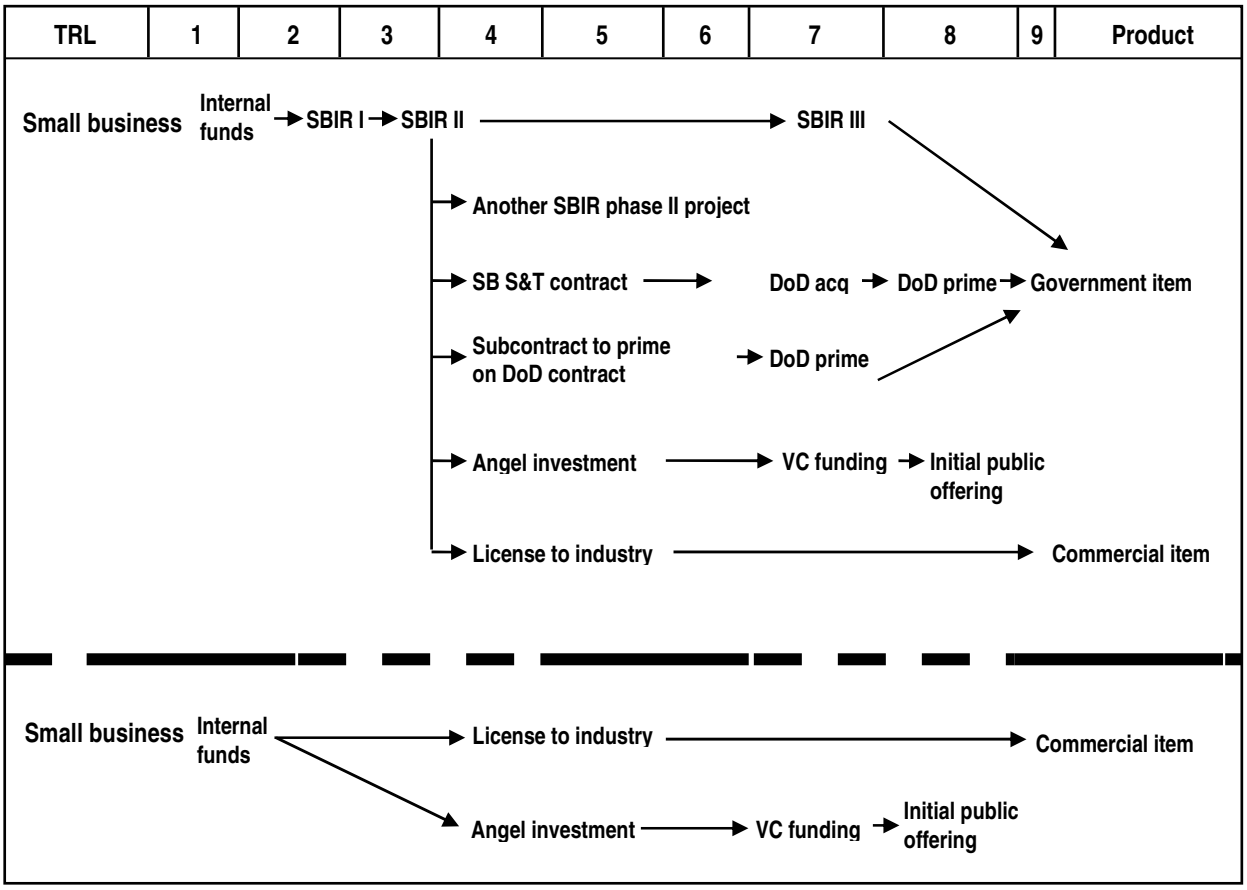


Figure D-2. Small Business-Unique Pathways to Transition

Note: "Pathways to transition" outlines the major funding decision points in relationship to DoD TRLs. The TRLs shown are representative of typical decision points, but are not fixed. "Contract" means a contractual instrument appropriate for the situation, such as FAR Part 12, FAR Part 15, modifications (e.g., VECPs), or OTs.

The driving force behind the development of the TATM process was the critical need to increase the rate of technology transition and to decrease system development cost, schedule, and performance risk. The TATM process provides: a common framework for the management of technology transition; comprehensive assessments of supporting technology programs; an integrated, Web-based tool suite that enables technology project assessment and acquisition program linkage and synchronization; a methodology for the early identification of broader applications of emerging technologies and horizontal technology applications.

The identification of a technology project's link to a specific acquisition program and that program's milestone events provides the acquisition and S&T PMs invaluable insight into the relationship of their respective projects and programs. Using these linkages, the TATM process supports the development of program master schedules as well as the traceability of the capability needs that drive the entire program. Directly linking S&T projects and emerging capability needs to capability needs documents or to operational concepts enhances the systems engineering process and enables the formalization of the technology transition management process.

The visibility that the TATM process provides into both S&T and acquisition program costs, schedules, and risks allows both communities to plan and prepare for technology transition.

- S&T managers can mature promising technologies to requisite levels to synchronize with acquisition program transition windows.
- Acquisition PMs can plan for technology insertion into their systems.
- Warfighters and the user community can plan for integration of future operational capability needs into the future battlefield.
- The Sustainment community can plan to sustain and support the system.

The resulting process provides a common methodology to: develop technology transition roadmaps; conduct technical risk assessments; and determine which projects are worthy of more rigorous non-technical risk assessments. Additionally, the TATM process forces the development of Technology Transition Agreements early in the technology transition management cycle and aids the prioritization efforts of both the S&T and acquisition communities. TATM provides synchronizing information for the warfighting community to successfully time phase capability needs and for the Sustainment community to plan and implement the required support infrastructures.

TATM is, at its core, a disciplined risk assessment process that is implemented through the tenets of DoD's Integrated Product and Process Development (IPPD), i.e. Integrated Process Teams (IPTs). By synchronizing the efforts and expectations of the stakeholder communities early on in the acquisition lifecycle and by bringing order to an often chaotic process, TATM greatly improves the odds for successful technology transition and ultimately the successful deployment of a needed capability into the hands of the warfighter.

For more information on the TATM process, point of contact information, and the latest version of the *TATM Process Guide*, go to http://acc.dau.mil/docs/tatm/.

APPENDIX E
RESEARCH AND TECHNOLOGY PROTECTION PLANNING

Research and Technology Protection (RTP) planning should begin early during pre-acquisition and extend through the product life cycle to demilitarization and disposal.

Although science and technology information is usually suitable for unlimited public release, sometimes the information is classified for national security. Also, sometimes the information becomes Controlled Unclassified Information (CUI) because of restrictions imposed by regulation or statute. The Research, Development, Test and Evaluation (RDT&E) site directors are encouraged to monitor their classified information and CUI to find technologies whose intrinsic military value is so clear that the site director wants to encourage people from Classified Information (CI) and security to give specialized support in these technology areas. Technical information recommended by the site directors for specialized support is known as Designated Science and Technology Information (DS&TI).

Once an acquisition program is established, the program manager is responsible for reviewing technologies in the program to determine if Critical Program Information (CPI) exists. If the program has CPI, a Program Protection Plan (PPP) must be developed to ensure that the protection of information continues, not only during systems acquisition but through demilitarization and disposal as well.

Protection of DS&TI and CPI will range from educating scientists and engineers performing fundamental research about threat awareness to implementing a PPP. The Department of Defense Directive (DoDD) 5200.39, *Security, Intelligence, and Counterintelligence Support to Acquisition Program Protection*, September 10, 1997, outlines protecting information. Information about establishing a security classification guide is in DoDD 5200.1-R, *Department of Defense Information Security Program Regulation*, January 17, 1997, or DoDD 5220.22-M, *National Industrial Security Program Operating Manual (NISPOM)*.

DoD CI organizations have specially trained individuals who give tailored CI support to protecting research and technology. A CI Support Plan (CISP) will outline how CI specialists will work with the owners of the information and processes to protect the research and technology information from inadvertent compromise and threats. A CISP must be developed for each RDT&E facility and each acquisition program with CPI.

The PPP is the single-source document used for coordinating and integrating all protection designed to deny CPI access to anyone not authorized or not having a need-to-know. In addition, the PPP prevents this type of information from being inadvertently disclosed to foreign interests. The PPP must contain provisions for denying inadvertent or unauthorized access by foreign interests. If there is to be foreign involvement in the program's development or foreign access to the system, the PPP will include a technology assessment and control plan (See DoDD 5530.3, *International Agreements*, November 21, 2003).

When applicable, the PPP will address anti-tamper techniques and System Security Engineering (SSE). Acquisition program managers responsible for U.S. systems that may be co-developed by or sold to foreign governments, or that might not remain in U.S. control (e.g., theft, battlefield loss) must develop and implement these measures. The measures allow the United States to meet foreign customer needs for advanced systems and capabilities while ensuring that U.S. technological investment and equities are protected.

PROTECTION IN INTERNATIONAL PROGRAMS

In the current global environment, the DoD tries to include foreign allies and friendly foreign countries as partners in developing, acquiring, and managing the life cycle of defense systems. Early involvement with foreign partners is encouraged; such cooperative foreign government partnerships should begin whenever possible when requirements are being defined. By successfully developing programs cooperatively, the desirable objectives of standardization, commonality, and interoperability will be promoted. The U.S. government and its foreign government partners will benefit from shared development costs, reduced production and procurement savings from economies of scale, and strengthened domestic industrial bases. Similarly, DoD is pivotal in executing security cooperation programs that support national security objectives and foreign policy goals. U.S. defense system sales are a major aspect of security cooperation.

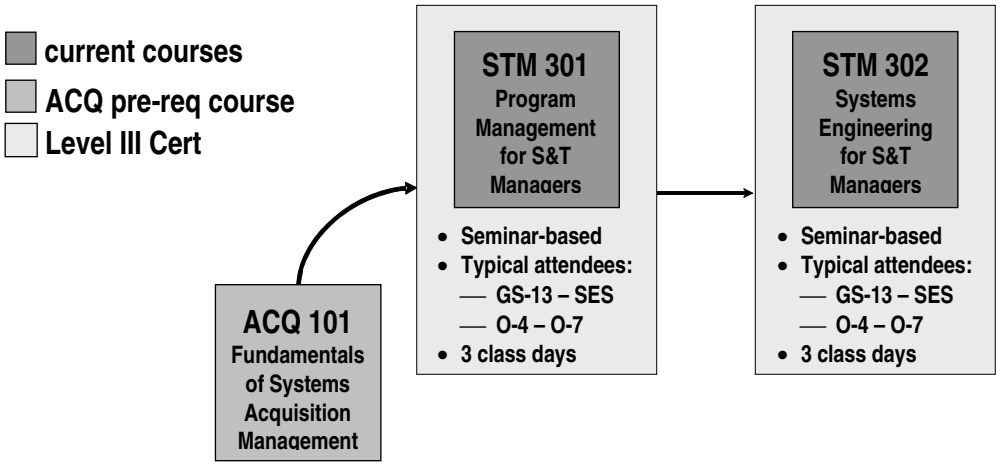
The overall protection of technology has many facets as it moves through research and acquisitions. Proper marking of technical data, and up-to-date classification guides assist in the process. Before discussing technology with a potential international partner, DoD must review the technology to be disclosed and make a decision about disclosing the technology as described in DoDD 5230.11 *Disclosure of Classified Military Information to Foreign Governments and International Organizations,* June 16, 1992. Non-government laboratories and private companies participating in the program must consider export-licensing requirements even to begin discussions with non-U.S. persons. Visits and assignment of foreign persons to a DoD location to participate in the programs must be arranged in accordance with DoDD 5230.20 *Visits, Assignments and Exchanges of Foreign Nationals*, August 12, 1998.

Partnering with the larger “security community” during an endeavor in which foreign participation is a possibility will mitigate risk of compromising technology and prevent security requirements from becoming an obstacle to the program progressing. The security community has established working relationships with their counterparts in other nations for standardizing requirements and resolving problems expeditiously. Make the relationships a resource for your success.

APPENDIX F
DOD SCIENCE AND TECHNOLGY CAREER FIELD

The Department of Defense's acquisition workforce is comprised of thirteen career fields including Science and Technology (S&T). DoD S&T managers are typically engineers and scientists involved in the Concept Refinement (CR) and Technology Development (TD) Phase and/or the System Development and Demonstration (SDD) Phase of the Defense Acquisition Process. Primary duties include developing overall program goals for S&T funds; acquiring the services of scientists, engineers, and technical support personnel, who are experts in their fields, to perform S&T research for DoD; providing oversight of S&T performers, including universities, industry and Federal Government organizations; and interfacing with the technology customer to expedite the transition of technology to the user. Based upon education and experience, members of this workforce progress through three levels of certification as depicted below.

Science & Technology Management (STM) Career Track DAU Courses



The specific career field education requirements can be satisfied through completion of courses offered by the Defense Acquisition University (DAU). These courses are described below and further information is available on the DAU Web site at http://www.dau.mil.

ACQ 101: FUNDAMENTALS OF SYSTEMS ACQUISITION MANAGEMENT

This course provides a broad overview of the DoD systems acquisition process, covering all phases of acquisition. It introduces the requirements generation and resource allocation processes, the DoD 5000 Series documents governing the defense acquisition process, and current issues in system acquisition management. Designed for individuals who have little or no experience in DoD acquisition management, ACQ 101 has proven very useful to personnel in headquarters, program management, and functional or support offices.

Objectives: Students who successfully complete this course will be able to recognize:

- the fundamental precepts and bases of defense systems acquisition management;
- the diverse, interrelated, and changing nature in the different disciplines of defense systems acquisition management; and
- the regulations and governing structures of defense systems acquisition management.

Who Should Attend: This course is designed for military officers, O-1 through O-3, and DoD civilians, GS-5 through GS-9. However, the course is open to all ranks and grades.

Prerequisite: None

Length: This is a nonresident, self-paced course available through the Internet. Students must complete the course prior to the Enrollment Expiration Date provided in the "Enrollment Notification — Course Welcome" message.

Method of Delivery: Distance Learning

STM 301: PROGRAM MANAGEMENT FOR S&T MANAGERS
This course provides an understanding of the procedures and mechanisms used to transition advanced technologies into warfighting systems. Personnel associated with S&T program management will be able to understand the challenges presented in the weapons systems acquisition process, assess the implications of various technology transition mechanisms, and apply effective technology transition practices.

Objectives: Students who successfully complete this course will be able to:

- understand the challenge presented in the weapons systems acquisition process,
- assess the implications of various technology transition mechanisms, and
- apply effective technology transition practices.

Who Should Attend: Personnel whose duties include developing overall program goals for S&T funds; acquiring the services of scientists, engineers, and technical support personnel to perform S&T research for DoD; providing funds and oversight of the S&T performers, including universities, industry, and Federal Government organizations; and interfacing with the technology customers to expedite the transition of technology to the user. This course is recommended for civilians, GS-13 to SES, and military officers, O-4 to O-7.

Prerequisite: None

Recommended: ACQ 101 is highly recommended

Length: 3 class days

STM 302: SYSTEMS ENGINEERING FOR S&T MANAGERS
Systems Engineering for S&T Managers provides an understanding of the procedures and mechanisms used to transition advanced technologies into warfighting systems. Personnel associated with S&T program management will be able to apply the critical skills of the Systems Engineering and Integrated Product and Process Development (IPPD) processes. They will also assess the implications of various technology transition mechanisms and apply effective technology transition practices.

Objectives: Students who successfully complete the course will be able to:

- apply the principles of Systems Engineering Management and its various tools such as:
  - — Systems Engineering Process
  - — Configuration Management and Technology Readiness
  - — Risk Management
  - — Trade Studies
  - — Value Analysis
  - — Six Sigma
  - — Quality Function Deployment
  - — Design of Experiments
- assess the implications of various technology transition mechanisms using the IPPD process, including integrated product teams; and
- apply effective technology transition practices, such as transition exit criteria, transition plans, affordability analyses, and cost schedule reporting.

Who Should Attend: This course should be taken by personnel desiring certification at Level III and whose duties include: (1) developing overall program goals for S&T funds; (2) acquiring the services of scientists, engineers, and technical support personnel to perform S&T research for DoD; (3) providing funds and oversight of the S&T performers, including universities, industry, and Federal Government organizations; and (4) interfacing with the technology customers to expedite the technology transition to the user.

Prerequisite: STM 301

Length: 3 class days

Method of Delivery: Resident/On-site

In addition to these resident courses, DAU offers additional instruction in areas ranging from the DoD 5000 Series Instructions to Other Transactions via their continuous learning center. A list of offerings is available through http://clc.dau.mil/kc/no_login/portal.asp.

APPENDIX G
GLOSSARY

ACRONYMS AND ABBREVIATIONS

ABS	Anti-lock Braking System
ACAT IAM	Acquisition Category I (Major Automated Information Systems)
ACAT IC	Acquisition Category I (Component)
ACAT ID	Acquisition Category I (Defense)
ACC	Acquisition Community Connection
ACTD	Advanced Concept Technology Demonstration
AECA	Arms Export Control Act
AFATC	Air Force Applied Technology Council
AFRL	Air Force Research Laboratory
AF WRAP	Air Force Warfighter Rapid Acquisition Program
AMD	Advanced Motor Drive
AoA	Analysis of Alternative
APB	Acquisition Program Baseline
ArF	Argon Flouride
ARL	Army Research Laboratory
AS&C	Advanced Systems and Concepts
ASDS	Advanced SEAL Delivery System
ASTMP	Army Science and Technology Master Plan
ATD	Advanced Technology Demonstration
AT&L	Acquisition, Technology, and Logistics
ATMI	Advanced Technology Materials, Inc.
AXT	American Xtal Technology, Inc.
BAA	Broad Agency Announcements
BCP	Budget Change Proposal
BMDO	Ballistic Missile Defense Organization
BMP	Best Manufacturing Practices
C2	Command and Control
CAIG	Cost Analysis Improvement Group

CAIV	Cost as an Independent Variable
CAS	Cost Accounting Standard
CDD	Capabilities Development Document
CJCS	Chairman Joint Chiefs of Staff
CJCSI	Chairman Joint Chiefs of Staff Instruction
CJCSM	Chairman Joint Chiefs of Staff Manual
CLS	Contractor Logistics Support
CNA	Chief of Naval Analysis
CNO	Chief of Naval Operations
CNS	Communications, Navigation, and Surveillance
COCOM	Combatant Command
COTS	Commercial-off-the-Shelf
CPD	Capabilities Production Document
CR	Concept Refinement
CRADA	Cooperative Research and Development Agreement
CRD	Capstone Requirements Document
CSF	Critical Success Factors
CTO	Commercial Technology Office
CVNX	Aircraft Carrier, Nuclear, Experimental
CY	Calendar Year
DARO	Defense Airborne Reconnaissance Office
DARPA	Defense Advanced Research Projects Agency
DAS	Defense Acquisition System
DAU	Defense Acquisition University
DCAP	Defense Acquisition Challenge Program
DDR&E	Director, Defense Research and Engineering
DERF	Defense Emergency Response Fund
DFARS	Defense Federal Acquisition Regulation Supplement
DFAS	Defense Finance and Accounting Service
DISA	Defense Information Systems Agency
DLA	Defense Logistics Agency
DoC	Department of Commerce
DoD	Department of Defense

DoDGAR	Department of Defense Grants Agreement Regulation
DoDGARS	Department of Defense Grant and Agreement Regulatory System
DoE	Department of Energy
DoS	Department of State
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities
DPG	Defense Planning Guidance
DRR	Design Readiness Review
DSB	Defense Science Board
DSR	Digital Systems Resources, Inc.
DSS	Decision Support System
DTAP	Defense Technical Area Plan
DTC	Design-To-Cost
DT&E	Developmental Test and Evaluation
DTIC	Defense Technical Information Center
DTO	Defense Technology Objectives
DUSD(AS&C)	Deputy Under Secretary of Defense for Advanced Systems and Concepts
DUSD(S&T)	Deputy Under Secretary of Defense for Science and Technology
DUS&T	Dual Use Science and Technology
EA	Evolutionary Acquisition
EAA	Export Administration Act
ECS	Environmental Control System
EDM	Engineering Development Model
EELV	Evolved Expandable Launch Vehicle
EMA	Electromechanical Actuator
EMRL	Engineering and Manufacturing Readiness Level
EPA	Environmental Protection Agency
ESH	Environmental, Safety, and Health
ESSI	Earth Search Sciences, Inc.
ESSM	Evolved Sea Sparrow Missile
FAA	Functional Area Analysis
FAR	Federal Acquisition Regulation
FASA	Federal Acquisition Streamlining Act
FCB	Functional Capabilities Board

FDA	Food and Drug Administration
FEDRIP	Federal Research in Progress
FFRDC	Federally Funded Research and Development Center
FMS	Financial Management System; Foreign Military Sales
FMTV	Family of Medium Tactical Vehicles
FNA	Functional Needs Analysis
FOC	Full Operational Capability
FOIA	Freedom of Information Act
FOS	Family of Systems
FRH	Flameless Ration Heater
FRP	Full Rate Production
FRP&D	Full Rate Production and Deployment
FRPDR	Full Rate Production Decision Review
FSA	Functional Solutions Analysis
FY	Fiscal Year
FYDP	Future Years Defense Plan
GAO	General Accounting Office
GaAs	Gallium Arsenide
GFE	Government Furnished Equipment
GPLR	Government Purpose License Rights
HF	High Frequency
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HSI	Hyperspectral Imagery
HSLA	High-Strength Low-Alloy
HTV	Heavy Tactical Vehicle
IAC	Information and Analysis Center
ICD	Initial Capabilities Document
ID	Identification
IDCC	Integrated Dual-use Commercial Company
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IP	Intellectual Property
IPO	Initial Public Offering

IPPD	Integrated Product and Process Development
IPR	Intellectual Property Rights; also In Process/Progress Review
IPT	Integrated Product Team
IR&D	Independent Research and Development
IRS	Internal Revenue Service
ISMIS	Intelligent Shock Mitigation and Isolation System
IT	Information Technology
ITAR	International Traffic in Arms Regulations
ITS	Information Technology System
JCB	Joint Capabilities Board
JCIDS	Joint Capabilities Integration and Development System
JDMTP	Joint Defense Manufacturing Technology Panel
JE	Joint Experimentation
JFCOM	Joint Forces Command
JPG	Joint Programming Guidance
JROC	Joint Requirements Oversight Council
JV	Joint Vision
JWCA	Joint Warfighting Capabilities Assessment
JWCO	Joint Warfighting Capability Objective
KPP	Key Performance Parameter
KrF	Krypton Flouride
LCC	Life Cycle Cost
LFT&E	Live Fire Test and Evaluation
LMCS	Lockheed Martin Control Systems
LMRS	Long-Term Mine Reconnaissance System
LRIP	Low Rate Initial Production
LS	Logistics Support
M&S	Modeling and Simulation
MAIS	Major Automated Information System
ManTech	Manufacturing Technology
MATRIS	Manpower and Training Research Information System
MCCDC	Marine Corps Combat Development Command
MDA	Milestone Decision Authority; also Missile Defense Agency

MDAP	Major Defense Acquisition Program
MEA	More Electric Aircraft
MPP	Multipurpose Processor
MRI	Magnetic Resonance Imaging
MSFC	Marshall Space Flight Center
MTIAC	Manufacturing Technology Information Analysis Center
NAC	National Automotive Center
NASA	National Aeronautics and Space Administration
NASDAQ	National Association of Securities Dealers Automated Quotation
NATIBO	North American Technology Industrial Base Organization
NAVSEA	Naval Sea Systems Command
NDAA	National Defense Authorization Act
NEMO	Naval EarthMap Observer
NGA	National Geospatial-Intelligence Agency
NIMA	National Imagery and Mapping Agency
NISC	National Information Services Corporation
NRL	Naval Research Laboratory
NSA	National Security Agency
NSC	National Semiconductor Corporation
NSIAD	National Security and International Affairs Division
NSF	National Science Foundation
NSS	National Security Strategy; National Security System
NTDC	Non-Traditional Defense Contractor
NTIS	National Technical Information Service
NTTC	National Technology Transfer Center
NVESD	Night Vision and Electronic Sensors Directorate
O&S	Operations and Support
OCR	Optical Character Recognition
OE	Operational Effectiveness
OER	Officer Evaluation Reports
OIPT	Overarching Integrated Product Team
OMB	Office of Management and Budget
ONR	Office of Naval Research

ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT	Other Transaction
OT&E	Operational Test and Evaluation
OTA	Operational Test Authority
OTT	Office of Technology Transition
OUSD(AT&L)	Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics)
P3I	Pre-Planned Product Improvement
PB	President's Budget
PBBE	Performance-Based Business Environment
PBP	Performance-Based Payment
PCP	Program Change Proposal
PEBB	Power Electronic Building Blocks
PEF	Pulsed Electric Fields
PEO	Program Executive Officer
PIA	Post-Independent Analysis
PIPT	Program-level Integrated Product Team
PIT	Process Improvement Team
P.L.	Public Law
PMs	Program Managers
PNVG	Panoramic Night Vision Goggles
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting and Execution
PSS	Predictive Software Solutions
QA	Quality Assurance
R&D	Research and Development
RA	Research Announcement
RAP	Resource Allocation Process
RDT&E	Research, Development, Test, and Evaluation
RFP	Request for Proposal
RGS	Requirements Generation System
RIT	Rapid Improvement Team
ROI	Return On Investment

RTOC	Reduction in Total Operating Costs
S&T	Science and Technology
SAE	Service Acquisition Executive
SAS	Synthetic Aperture Sonar
SBA	Small Business Administration
SBIR	Small Business Innovation Research
SD	System Demonstration
SDD	System Development and Demonstration
SECDEF	Secretary of Defense
SI	System Integration
SIS	Share-In-Savings
SMART Net	Simulation and Modeling for Adaptive Real-Time Networks
SOCOM	Special Operations Command
SOO	Statement of Objective
SOS	System of Systems
SOW	Statement of Work
SPG	Strategic Planning Guidance
STTR	Small Business Technology Transfer
T2	Technology Transfer
T&E	Test and Evaluation
TACOM	Tank-Automotive and Armaments Command
TATM	Technology Assessment and Transition Management
TAV	Total Asset Visibility
TD	Technology Development
TDC	Traditional Defense Contractor
TDS	Technology Development Strategy
TEMP	Test and Evaluation Master Plan
THAAD	Theater High Altitude Area Defense
TIA	Technology Investment Agreement
TINA	Truth in Negotiations Act
Title III	Defense Production Act Title III Program
TOC	Total Ownership Cost
TRADOC	Training and Doctrine Command (Army)

TRL	Technology Readiness Level
TSWG	Technical Support Working Group
TTC	Technical Transition Council
TTI	Technology Transition Initiative
TTWG	Technical Transition Working Group
UAV	Unmanned Aerial Vehicle
UCAV	Unmanned Combat Aerial Vehicle
UHF	Ultra High Frequency
UOC	Unit Operation Center
U.S.	United States
U.S.C.	United States Code
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology, and Logistics)
USJFCOM	U.S. Joint Forces Command
USPS	United States Postal Service
USSOCOM	U.S. Special Operations Command
UV	Ultraviolet
VC	Venture Capital
VE	Value Engineering
VECP	Value Engineering Change Proposal
VHF	Very High Frequency
VTE	Virtual Technology Expo
WIPT	Working-level Integrated Product Team
WRAP	Warfighter Rapid Acquisition Program

DEFINITIONS

Acquisition	The act of acquiring goods or services for directly benefiting the government or for its use, e.g., buying something that the government needs.
Acquisition Category (ACAT)	Categories established to facilitate decentralized decision-making and execution, and compliance with statutorily imposed requirements. The categories determine the level of review, decision authority and applicable procedures. The specific definition for each acquisition category is contained in DoDI 5000.2.
Advanced Concept Technology Demonstration (ACTD)	ACTDs are pre-acquisition programs designed to enable users to understand proposed new capabilities for which no user experience base exists. Specifically, ACTDs provide the warfighter community an opportunity to develop and refine a concept of operations to fully exploit the capability under evaluation; evolve its capability needs as it gains experience and understanding of the capability; and operate militarily useful quantities of prototype systems in realistic military demonstrations, and on that basis, assess the military usefulness of the proposed capability.
Advanced Technology Demonstration (ATD)	A process for managing science and technology programs that demonstrate a military capability in a joint warfighting experiment, battle lab experiment, demonstration, field test, or simulation.
Affordability Objective	An indication by the warfighters of the relative economic value a capability has when compared to alternative or competing priorities for budget resources.
Analysis of Alternatives (AoA)	The evaluation of the operational effectiveness, operational suitability, and estimated costs of alternative systems to meet a mission capability. The analysis assesses the advantages and disadvantages of alternatives being considered to satisfy capabilities, including the sensitivity of each alternative to possible changes in key assumptions or variables.
Architecture	The structure of components, their relationships, and the principles and guidelines that govern their design and evolution over time.
Assistance	Supporting or simulating activities for improving the public good.
Award-Term Incentive	A performance-based (non-cash) incentive designed to entice a contractor to transition a workload well, provide superior support, and control prices by extending or reducing the term directly depending on performance.
Best Value	The most advantageous trade-off between price and performance for the government. Best value is determined through a process that

	compares strengths, weaknesses, risk, price, and performance in accordance with selection criteria, to select the most advantageous value to the government.
Broad Agency Announcement (BAA)	A competitive solicitation method, which can be used for basic and applied research (science and technology) and for developing "state-of-the-art" goods or services not related to developing a specific system or procuring hardware. The BAAs are announced on the Federal Business Opportunities Web site[1] and are general in nature, describing areas of research interest (including criteria for selecting proposals) and soliciting the participation of all offerors capable of satisfying the government's need.
Capability	The ability to execute a specified course of action. It is defined by an operational user and expressed in broad operational terms in the format of an initial capabilities document or a DOTMLPF change recommendation. In the case of material proposals, the definition will progressively evolve to DOTMLPF performance attributes identified in the CDD and the CPD.
Capability Development Document (CDD)	A document that captures the information necessary to develop a proposed program(s), normally using an evolutionary acquisition strategy. The CDD outlines an affordable increment of militarily useful, logistically supportable and technically mature capability.
Capability Needs Community	The warfighters or their representatives who develop new warfighting concepts and outline the capabilities needed to support them. It validates the military requirements for new capabilities and describes the specific performance parameters that are required for new systems.
Capability Production Document (CPD)	A document that addresses the production elements specific to a single increment of an acquisition program.
Capstone Requirements Document (CRD)	A document that contains capabilities-based requirements that facilitates the development of CDDs and CPDs by providing a common framework and operational concept to guide their development. Commonly used for systems-of-systems or families-of-systems.
Combat Developer	Command or agency that formulates doctrine, concepts, organization, material requirements and objectives. May be used generically to represent the user community role in the material acquisition process.

[1] http://www.fedbizopps.gov.

Contractor Logistics Support	The performance of maintenance and/or materiel management functions for a DoD system by a commercial activity. Historically done on an interim basis until systems support could be transitioned to a DoD organic capability. Current policy now allows for the provision of system support by contractors on a long-term basis. Also called Long-Term Contractor Logistics Support.
Cooperative Agreement	A legal instrument used by a federal agency to enter into a relationship whose principal purpose is assistance (that is, transferring something of value to the recipient for carrying out support or stimulation authorized by U.S. law). A form of financial assistance for circumstances in which the government wants to participate jointly with the recipient and to be substantially involved in the program. (See Grant.)
Critical Success Factor (CSF)	Critical management activities that define an acceptable deliverable or series of deliverables for a technology solution. CSFs are activities that can be tracked and measured and are based on performance.
Cultural Barriers	The disincentives, communication shortfalls, and suboptimization that occurs among the different communities that transition technology.
Defense Acquisition Challenge Program	A new program required by the FY03 NDAA. The SECDEF, acting through the USD(AT&L), will establish a program to enable increasing the introduction of innovative and cost-saving technology in the DoD acquisition programs.
Defense Acquisition System	Management process by which DoD provides effective, affordable, and timely systems to the users. (DoDD 5000.1)
Defense Contractor	A commercial entity that traditionally does a significant part of its business with DoD.
Defense Industry	The commercial companies that support DoD.
Defense Production Act Title III Program (Title III)	This Act creates assured, affordable, and commercially viable production capabilities and capacities for items that are essential to the national defense by stimulating private investment in key production resources.
Defense Technical Area Plan (DTAP)	Documents the focus, content, and principal objectives of the overall DoD S&T effort. DTAP is organized according to technology areas and is a horizontal overview of programs from all Services and agencies.

Defense Technology Objective (DTO)	Objective that is used to guide the investment in S&T. Each DTO describes a specific technology advancement that will be developed or demonstrated, the anticipated date of technology availability, the specific benefits resulting from the technology advancement, and the approximate funding required to achieve the new capability.
Developmental Test and Evaluation	1. Any testing used to assist in the development and maturation of products, product elements, or manufacturing or support processes. 2. Any engineering-type test used to verify status of technical progress, verify that design risks are minimized, substantiate achievement of contract technical performance, and certify readiness for initial Operational Testing. Development tests generally require instrumentation and measurements and are accomplished by engineers, technicians, or soldier operator-maintainer test personnel in a controlled environment to facilitate failure analysis.
Defense Technical Information Center (DTIC) Independent Research and Development (IR&D) Database	A forum for obtaining information about IR&D projects and results.
DoD 5000 Series	"DoD 5000 Series" refers collectively to DoDD 5000.1 and DoDI 5000.2, and to the former 5000.2R, now known as *The Defense Acquisition Guidebook*.
Engineering and Manufacturing Readiness Level (EMRL)	Extends the idea of Technology Readiness Levels (TRLs) to engineering and manufacturing issues. EMRLs make assessments of the system engineering and design, and the maturity of the resulting design, related materials, tooling, test equipment, manufacturing processes, quality and reliability, and key characteristics for ensuring a producible and affordable product.
Evolutionary Acquisition	The preferred DoD strategy for rapid acquisition of mature technology for the user according to DoDI 5000.2. An evolutionary approach delivers capability in increments, recognizing up front the need for future capability improvements. There are two approaches to achieving an EA: Spiral Development and Incremental Development: — **Spiral Development**: In this process, a desired capability is identified, but the end-state requirements are not known at program initiation. Requirements are refined through demonstration, risk management and continuous user feedback. Each increment provides the best possible capability, but the requirements for future increments depend on user feedback and technology maturation. According to DoDD 5000.1, spiral development is the preferred process for executing an EA strategy.

	— **Incremental Development**: In this process, a desired capability is identified, an end-state requirement is known, and that requirement is met over time by developing several increments, each dependent on available mature technology.
Execution of Funds	The process of obligating and committing funds.
Export Administration Act (EAA)	Act that administers the exportation of most commercial and dual-use technology.
Fielded Systems	Systems that have been procured and provided to operational elements.
Financial Community	The government organizations and personnel who manage the resources needed by the other communities, and fund the programs and systems needed for transitioning technology. The financial community is in charge of financial activities, budget officers who prepare and defend defense budgets, and personnel who manage the spending or execution of those budgets. The community also provides financial support by paying defense contractors and supplying accounting information and services.
Financial Management System (FMS)	The system in which the funding is justified, obtained, and allocated. The system provides needed resources to DoD's warfighters. PPBE is part of the FMS.
Fixed-Price Contract	These contracts provide for a firm fixed price or, in appropriate cases, an adjustable price. See the FAR, Subpart 16.2.
Focused Logistics	A JCS initiative which seeks the fusion of information, logistics, and transportation technologies to provide rapid crisis response by allowing for the tracking and shifting of assets en route and the delivery of tailored logistics and sustainment packages directly at the strategic, operational, or tactical level of operations.
Full Dimensional Protection	One of the key operational concepts in *Joint Vision 2020,* the joint force vision for the future. Full dimensional protection is the ability of the joint force to protect its personnel and the other assets needed for executing assigned tasks decisively.
Functional area	A broad scope of related joint warfighting skills and attributes that may span the range of military operations. Specific skill groupings that make up the functional areas are approved by the JROC.
Functional Capabilities Board (FCB)	A permanently established body that is responsible for the organization, analysis and prioritization of joint warfighting capabilities within an assigned functional area.

Increment	A militarily useful and supportable operational capability that can be effectively developed, produced or acquired, deployed and sustained. Each increment of capability will have its own set of threshold and objective values set by the user.
Incremental Development	In this process, a desired capability is identified, an end state requirement is known, and that requirement is met over time by developing several increments, each depending on available mature technology.
Initial Capabilities Document (ICD)	Documents the need for a materiel approach to a specific capability gap derived from an initial analysis of materiel approaches executed by the operational user and, as required, an independent analysis of materiel alternatives. It defines the capability gap in terms of the functional area, the relevant range of military operations, desired effects and time. The ICD summarizes the results of the DOTMLPF analysis and describes why non-materiel changes alone have been judged inadequate in fully providing the capability. Replaces the Mission Need Statement.
Integrated Product Team (IPT)	Team composed of representatives from appropriate functional disciplines working together to build successful programs, identify and resolve issues, and make sound and timely recommendations to facilitate decision making. There are three types of IPTs: Overarching IPTs (OIPTs) that focus on strategic guidance, program assessment, and issue resolution; Working-level IPTs (WIPTs) that identify and resolve program issues, determine program status, and seek opportunities for acquisition reform; and Program-level IPTs (PIPTs) that focus on program execution and may include representatives from both government and after contract award industry.
Intellectual Property Rights (IPR)	A company's rights in patents, copyrights, trademarks, and trade secrets.
International Traffic in Arms Regulations (ITAR)	Regulations that provide a broad authority for denying or modifying proposed exports for reasons of national security or foreign policy.
Interoperability	The ability of systems, units, or forces to provide data, information, materiel, and services to (and accept the same from) other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. National Security System (NSS) and Information Technology System (ITS) interoperability includes both the technical exchange of information and the end-to-end Operational Effectiveness (OE) of that exchanged information as required for mission accomplishment. CJCSI 6212.01B covers interoperability.

Interoperability Requirement	A requirement that ensures the interoperability of systems in a Service, between Services, and with allies and coalition forces. The requirement also ensures that the technology can interface with other systems on the battlefield. CJCSI 3170.01C mandates that interoperability be a Key Performance Parameter (KPP).
Invention Secrecy Act of 1951	Act that requires the government to impose "secrecy orders" on patent applications whose disclosure would be detrimental to national security.
Joint Capabilities Board (JCB)	The JCB functions to assist the JROC in carrying out its duties and responsibilities. The JCB reviews and, if appropriate, endorses all JCIDS and DOTMLPF proposals prior to their submission to the JROC. The JCB is chaired by the Joint Staff, J-8, Director of Force Structure, Resources, and Assessment. It is comprised of Flag/General officer representatives of the Services.
Joint Capabilities Integration and Development System (JCIDS)	JCIDS is defined in CJCSI 3170.01C (June 2003) and replaces the Requirements Generation System (RGS) that was defined by CJCSI 3170.01B (now cancelled). JCIDS supports the CJCS and the JROC in identifying, assessing, and prioritizing joint military capability needs as required by law.
Key Performance Parameters (KPPs)	Those minimum attributes or characteristics considered most essential for an effective military capability. KPPs are validated by the JROC for JROC Interest documents, by the FCB for Joint Impact documents, and by the DoD Component for Joint Integration or Independent documents. The CDD and the CPD KPPs are included verbatim in the APB. (CJCSI 3170.01C)
Legacy Systems	Military systems and software whose acquisition has been completed, and are in operation with the Services.
Lessons Learned	Capitalizing on past errors in judgment, materiel failures, wrong timing, or other mistakes to ultimately improve a situation or system.
Manufacturing Technology (ManTech)	Refers to any action which has as its objective the timely establishment or improvement of the manufacturing processes, techniques, or equipment required to support current and projected programs, and the assurance of the availability to produce, reduce lead-time, ensure economic availability of end items, reduce costs, increase efficiency, improve reliability, or to enhance safety and anti-pollution measures.
Material Developer	A command or agency responsible for (R&D) and production validation of an item.

Materiel	A generic word for equipment. It is inherently plural. It is distinguished from material, which is what items are made of. Material can be singular or plural, e.g. aircraft are materiel. The materials that aircraft are made of include aluminum, steel, plastic, glass, etc.
Modular Open System	An integrated business and technical strategy that facilitates the integration of the latest technologies and products that facilitate affordable and supportable modernization of fielded assets.
National Technology Transfer Center (NTTC)	A leader in technology transfer and commercialization. NTCC aids economic development through the mapping of technologies needed to technologies available. It offers a complete portfolio of products and services that enable U.S. companies to find technologies, facilities, and world-class researchers within the federal labs and agencies with which they can partner.
Non-Traditional Supplier (NTS)	An entity that does not normally provide goods and services to the DoD.
Operator	An operational command or agency that employs the acquired system for the benefit of users. Operators may also be users.
Other Transaction (OT)	Term commonly used to refer to Title 10 U.S.C. 2371 authority to enter into transactions other than contracts, grants, or cooperative agreements.
Other Transactions for Prototype Project	Authorizes the use of OTs, under the authority of Title 10 U.S.C. 2371, for prototype projects directly relevant to weapons or weapons systems proposed to be acquired or developed by the DoD. They generally are not subject to the federal laws and regulations governing procurement contracts.
Planning, Programming, Budgeting, Execution (PPBE)	The primary resource allocation process of DoD. A primary component of the Financial Management System. It is one of three major DSSs for defense acquisition along with JCIDS and the Defense Acquisition System. It is a formal, systematic structure for making decisions on policy, strategy, and the development of forces and capabilities to accomplish anticipated missions. PPBE is a biennial process which in the On-Year can produce a DPG, approved POMs for the Military Departments and Defense Agencies covering six years, and the DoD portion of the President's Budget (PB) covering two years. In the Off-Year, BCPs and PCPs are used to adjust the FYDP to take into account "fact of life changes," inflation, new programmatic initiatives, and the result of congressional enactment of the previously submitted PB.

Procurement Contract	A system by which the government generally satisfies its acquisition requirements. The framework for procurement contracts is FAR and DFARS based, and those regulations define a system that provides for quality products on a timely basis at reasonable costs. The system relies on full and open competition (with some exceptions) and is available to all responsible contractors.
Profit Incentive	A provision in DFARS to increase the negotiated fee based on contractor use of innovative technology. This incentive is based on a congressional desire to encourage innovation and is completely consistent with DoD's objectives.
Request for Proposal (RFP)	A solicitation used in negotiated acquisition to communicate government requirements to prospective contractor and to solicit proposals.
Research and Development (R&D) Community	The scientists, engineers, and other professionals that provide the expertise necessary to field the technologies in military systems. Its focus is on developing and supporting technologically superior and affordable systems for warfighters. It evaluates technologies, conducts applied research, performs engineering and design work for candidate systems and components. It is responsible for getting the technology to the field.
Science and Technology (S&T) Community	The academics, scientists, and managers of S&T programs who develop knowledge in the key technologies that will be needed for future systems and equipment. It includes technology development sources such as government labs, agencies (e.g., the DARPA), and industry labs. It focuses on developing and understanding technologies.
Security Community	The intelligence, counterintelligence, security, and foreign disclosure organizations, staff, and personnel who provide advice to the communities concerning technologies desired by adversaries, capabilities for obtaining such technologies, countermeasures for protecting the technologies, and authorizations to transfer the technology to other countries.
Seed Money	Contracts, grants, cooperative agreements or OTs.
Share-In-Savings (SIS) Provision	Cost-based incentives now referred to by DoD as "efficiency savings." A SIS contract encourages contractors to apply ingenuity and innovation to get the work done quickly and efficiently to share in the savings attributed to their planning and execution.
Single Step Acquisition	An acquisition strategy where all requirements are identified up front and delivered to the user in a single development rather than in a series of incremental developments.

Simulation and Modeling For Adaptive Real-Time Networks (SMART Net)	A program that uses a series of M&S tools to help evaluate technology tradeoffs.
Small Business Innovation Research (SBIR)	A program created by Congress in 1982 to help small businesses more actively participate in federal R&D.
Small Business Technology Transfer (STTR)	A small business program that expands funding opportunities in the federal innovation R&D arena. Central to the program is the expansion of the public/private sector partnership to include joint venture opportunities for small businesses and the nation's premier non-profit research institutions.
Solution Space	The maximum flexibility allowed developers in determining how essential capabilities are met.
Spiral Development	In this process, a desired capability is identified, but the end state requirements are not known at program initiation. Requirements are refined through demonstration, risk management and continuous user feedback. Each increment provides the best possible capability, but the requirements for future increments depend on user feedback and technology maturation. According to DoDI 5000.2, spiral development is the preferred process for executing an EA strategy.
Subcontract Integration Plan	A plan that encourages favorable partnerships between large and small businesses, and encourages prime contractors to implement the best technology solutions. It describes how a prime contractor plans to maintain the competitive technology environment at the subcontractor level and create competitive alternatives.
Supportability	The degree to which a device, equipment, or weapon system is open to effective attack due to one or more inherent weaknesses. Susceptibility is a function of operational tactics, countermeasures, probability of enemy fielding a threat, etc. Susceptibility is considered a subset of survivability.
Sustainment Community	The operators, program and product managers, item managers, and logisticians who operate, maintain and improve the equipment through the decades of service that are expected for major systems. It provides a support environment that maintains long-term competitive pressures and improves weapons system reliability, maintainability, and supportability through technology refreshment and other means.
Technical Data Package (TDP)	A technical description of an item adequate for supporting an acquisition strategy, production, engineering, and LS. The description defines the required design configuration and procedures

	to ensure adequacy of item performance. It consists of all applicable TD such as drawings, associated lists, specifications, standards, performance requirements, QA provisions, and packaging details. One of the traditional LS elements.
Technological Obsolescence	When a newer technology replaces an older one and the capability to produce the older technology falls into disuse and is gradually lost.
Technology Investment Agreement (TIA)	Allows the DoD to enter into agreements with firms that will not or cannot participate in government cost-reimbursement R&D FAR contracts or standard federal assistance awards.
Technology Readiness Level (TRL)	How a PM determines that a technology developed by industry or a government laboratory is ready or mature enough to transition into a production of quantities to satisfy the military users. Defined in the *Interim Defense Acquisition Guidebook*.
Technology Refreshment	A strategy to provide cost-effective support and upgrade strategies, to keep a program ahead of the obsolescence curve. This strategy should result in regular upgrades instead of major end-of-life modifications or follow-on systems.
Technology Road Mapping	Involves the process of integrating warfighter needs with resources and technology opportunities by mapping probable paths for transition.
Technology Transfer	Technology transfer is the process of sharing knowledge gained in federal laboratories with the private sector, generally for encouraging new commercial markets and applications.
Technology Transition	The process of applying critical technology in military systems to provide an effective weapons and support system — in the quantity and quality needed by the warfighter to carry out assigned missions and at the "best value" as measured by the warfighter.
Test and Evaluation (T&E) Community	The government organizations and personnel who ensure that the systems perform as intended, and are safe to operate in the challenging military operational environment. It provides an independent assessment of how well systems perform technically, how well the system fulfills the requirements in requirements documents, and whether systems are safe, operationally effective, and suitable and survivable for their intended use in military operations.
Traditional Defense Contractor (TDC)	An entity that normally provides goods and services to the DoD.

Unfunded Mandates	Establishing a requirement for a capability without providing the resources necessary to acquire the capability.
Unsolicited Proposal	Where industry creates its own contracting opportunities by submitting unsolicited proposals to perform R&D work or to introduce a new or improved item that may be of interest to DoD.
User	An operational command or agency that receives or will receive benefit from the acquired system. Combatant commanders and their Service Component commands are the users. There may be more than one user for a system. Because the Service Component commands are required to organize, equip, and train forces for the combatant commanders, they are seen as users for systems. The Chiefs of the Services and heads of other DoD Components are validation and approval authorities and are not viewed as users.
Value Engineering (VE)	Has two aspects: a financial incentive to get contractors and subcontractors to reduce the cost of systems, supplies, and services and a rigorous methodology to maximize cost reduction. Contractors who participate in VE share in any net savings based on their financial risk. The VE process is unique because it maintains essential functions and lowers overall cost without degrading performance, reliability, maintenance, or safety.
Value Engineering Change Proposal (VECP)	A proposal to change an existing contract for a product or services, without impairing essential functions or characteristics, to reduce the overall cost to the agency.
Venture Capital (VC) Funding	Funding provided to invest in immature, high-risk/high-payoff technologies, in the hopes of "picking a winner." Venture capitalists "add value" to the technology developer by providing contacts, idea shaping, management, product development, marketing, commercialization, or funding. It is normally, but not exclusively, focused on small companies or "start ups."
Virtual Technology Expo (VTE)	A Web site that provides information to the defense community on emerging technologies, including descriptions of technology advancement, projected benefits, project milestones, and expected year of completion. (See Appendix B)
Warfighter Rapid Acquisition Program (WRAP)	A program established to address the gap in funding resulting from the time necessary to plan, program, budget, and receive appropriations for the procurement of a new technology. Its goal is to shorten the acquisition cycle and provide a bridge between experimentation and systems acquisition.

APPENDIX H
BIBLIOGRAPHY

Air Force Research Laboratory, *Success Stories: A Review of 2000*, Air Force Research Laboratory, Wright-Patterson Air Force Base, OH: August 27, 2001.

Air Force Research Laboratory Materials and Manufacturing Directorate, Toward More Affordable Defense Technology: IPPD (Integrated Product and Process Development) for S&T (Science and Technology) Quick Reference, James Gregory Associates, Inc. 1999. Available online at http://www.JamesGregory.com.

Aitcheson, Leslie, Ballistic Missile Defense Organization Technology Applications Program, "Technology Commercialization: How Is It Working for BMDO?" *The Update,* Summer/Fall 1998, pp. 1, 12, 13.

Aitcheson, Leslie, "Cashing in the Chips: BMDO Technology Is Making Big Payoffs for Semiconductor Producers," *BMDO Update,* Summer 2000, No. 34, pp. 1-3.

American Association for the Advancement of Science, *Guide to R&D Data — Historical Trends in Federal R&D (1955).* Accessed at http://www.aaas.org/spp/dspp/rd/guihist.htm on November 6, 2001.

American Institute of Physics, "Recommendations of Hart-Rudman National Security Report: R&D," *FYI: The AIP Bulletin of Science Policy News.* February 28, 2001, No. 22. Available at http://www.aip.org/enews/fyi/2001/022.html.

Ballistic Missile Defense Organization, *The 2000 BMDO Technology Applications Report: Technology, Working for You Now*, National Technology Transfer Center – Washington Operations: Alexandria, VA, June 2000.

Ballistic Missile Defense Organization, *Ballistic Missile Defense Organization 1998 Technology Applications Report*, BMDO Office of Technology Applications: Alexandria, VA.

Ballistic Missile Defense Organization Technology Applications Program, "Commercialization Is a Continuous Process," *BMDO Update* Winter 2001/2002, No. 40, p. 2.

Ballistic Missile Defense Organization Technology Applications Program, "White LEDs Illuminate a New Lighting Path: Wide-Bandgap Semiconductors Are Revolutionizing General Lighting," *BMDO Update* Winter 2000/2001, No. 36, pp. 1–3.

Borck, James R., "Disruptive Technologies: How to Snare an 800-Pound Gorilla: Stun him with a Disruptive Technology and Watch as he Stumbles to Adapt," *InfoWorld.* January 7, 2002, Vol. 24, No. 1, p. 33.

Bureau of National Affairs Inc., "Bush Signs Executive Order Creating Science, Technology Advisory Council," *Federal Contracts Report.* October 9, 2001, Vol. 76, No. 13, p. 368.

Chairman of the Joint Chiefs of Staff, *Joint Capabilities Integration and Development System*, 3170.01 and 3170.01C, June 2003. http://akss.dau.mil/darc/darc.html.

Committee on Integration of Commercial and Military Manufacturing in 2010 and Beyond, Board on Manufacturing and Engineering Design, Division on Engineering and Physical Sciences, National Research Council, *Equipping Tomorrow's Military Force: Integration of Commercial and Military Manufacturing in 2010 and Beyond*. Washington, DC: National Academy Press, 2002.

Coyle, Philip E. III, "Evolutionary Acquisition: Seven Ways to Know If You Are Placing Your Program at Unnecessary Risk," *Program Manager.* November-December 2000, p. 2.

DeCorpo, Jim, Chief Technology Officer of the Navy, "Rapid Technology Transitions into USN/USMC Acquisition Programs," Assistant Secretary of the Navy (Research, Development, and Acquisition) Testimony, 2001.

Defense Acquisition University, *Introduction to Defense Acquisition Management.* Sixth Edition, November 2003. http://www.dau.mil/pubs/gdbks/.

Defense Contract Audit Agency, Independent Research and Development and Bid and Proposal Costs Incurred by Major Defense Contractors in the Years 1998 and 1999, December 2000.

Defense Technical Information Center, *Independent Research and Development (IR&D), Information for DoD Personnel*, Fort Belvoir, VA.

Defense Technical Information Center, *Your Mark Will Make a Difference Down the Road! A Quick Reference for Marking DoD Documents*, September 2000.

Department of Defense, DoD 5000 Series. May 23, 2003. http://akss.dau.mil/darc/darc.html.

Deputy Under Secretary of Defense (Advanced Systems and Concepts), *Fiscal Year 2003 Advanced Concept Technology Demonstration (ACTD) Proposals*, October 30, 2001.

Deputy Under Secretary of Defense (Science and Technology), *Joint Warfighting Science and Technology Plan*, Washington, DC: February 2000.

Deputy Under Secretary of Defense (Science and Technology), Office of Technology Transition, *Dual-Use Science and Technology Process: Why Should Your Program Be Involved? What Strategies Do You Need to Be Successful?* July 2001. http://www.dtic.mil/dust.

Deputy Under Secretary of Defense (Science and Technology), Office of Technology Transition, *Report to Congress on the Activities of the DoD Office of Technology Transition*. March 2004.

Deputy Under Secretary of Defense (Science and Technology), *Technology Transition for Affordability: A Guide for S&T Program Managers*, April 2001.

DeSimone, L.D., Chairman of the Board and Chief Executive Officer, 3M, *Intellectual Capital: The Keystone to Competitiveness*, 1999.

Digital System Resources Inc., "Innovation in Defense Systems." Statement of Mr. Richard Carroll, founder and CEO, Digital System Resources Inc., to House Armed Services Committee, Military Research and Development Subcommittee, Washington, DC: March 22, 2001.

Digital System Resources Inc., "Toward Greater Public-Private Collaboration in Research & Development: How the Treatment of Intellectual Property Rights Is Minimizing Innovation in the Federal Government." Statement of Mr. Richard Carroll, founder and CEO, Digital System Resources Inc., to House Committee on Government Reform, Subcommittee on Technology and Procurement Policy, U.S. House of Representatives, Washington, DC: July 17, 2001.

"Equipment and Support Systems Definition" excerpt about seizing technological opportunities. Accessed December 5, 2001, at http://www.bmpcoe.org/guideline/books/bestprac/002024fb.html.

Evans, Jimmy, "Navy Strategic Planning Process for Science and Technology Demonstrations: Transitioning R&D Advanced Technology into the Fleet," *Program Manager*. July-August 2000, p. 50.

Federal Grant and Cooperative Agreement Act of 1997, P.L. 95-224. Subsequently recodified as Chapter 63 of P.L. 97-258 (31 U.S.C. 6301 et seq.).

Federal Register on "New Challenge Program" Accessed November 14, 2001, at http://www.mailgate.org/gov/gov.us.fed.dod.announce/msg01106.html.

Fellows, James, "Councils of War," *The Atlantic Monthly*. February 2002, p. 29.

Fiorino, Thomas D., Sr. Vice President, Andrulis Corporation, "Engineering Manufacturing Readiness Levels: A White Paper," October 30, 2001.

"From Beginning to End: The Life Cycle of Technology Products," *The Wall Street Journal*. October 15, 2001, p. R1.

General Accounting Office, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*. Report Number GAO/NSIAD-99-162, July 30, 1999.

General Accounting Office, *Best Practices: DoD Can Help Suppliers Contribute More to Weapons System Programs*. Report Number GAO/NSIAD-98-87, March 17, 1998.

General Accounting Office, *Best Practices: Successful Application to Weapon Acquisitions Requires Changes in DoD's Environment*. Report to the Subcommittee on Acquisition and Technology, Committee on Armed Services, U.S. Senate. Report Number GAO/NSIAD-98-56, February 1998.

General Accounting Office, *Defense Manufacturing Technology Program: More Joint Projects and Tracking of Results Could Benefit Program*. Report to Congressional Committees. Report Number GAO-01-943, September 2001.

General Accounting Office, *DoD Research — Acquiring Research by Nontraditional Means*. Report Number NSIAD-96-11, March 29, 1996.

General Accounting Office, *Export Controls: Clarification of Jurisdiction for Missile Technology Items Needed*. Report to the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate. Report Number GAO-02-120, October 2001.

General Accounting Office, *Intellectual Property: Industry and Agency Concerns over Intellectual Property Rights.* Report Number GAO-02-723T, May 10, 2002.

General Accounting Office, *Joint Strike Fighter Acquisition: Mature Critical Technologies Needed to Reduce Risks*, October 19, 2001.

General Accounting Office, *NASA: Better Mechanisms Needed for Sharing Lessons Learned*. Report to the Subcommittee on Space and Aeronautics, Committee on Science, House of Representatives. Report Number GAO-02-195, January 2002.

General Accounting Office, *National Laboratories: Better Performance Reporting Could Aid Oversight of Laboratory-Directed R&D Program*. Report to Congressional Requesters. Report Number GAO-01-927, September 2001.

Government Executive, "The Only Game in Town: Now Government is America's Hottest Technology Market," December 2001.

GovExec.com, "The Top Government Purchasers — Navy," August 1, 2001.

Graham, Margaret B.W., and Alec T. Shuldiner, *Corning and the Craft of Innovation*. New York: Oxford University Press, 2001.

Haines, Linda, "Technology Refreshment within DoD: Proactive Technology Refreshment Plan Offers DoD Programs Significant Performance, Cost, Schedule Benefits," *Program Manager.* March-April 2001, p. 22.

Harrington, Gia, Office of Naval Research, *Managing Disruptive Technologies and Innovations*. Presentation at the John F. Kennedy School of Government, New Haven, CT: Harvard University. November 19-20, 2001.

Hundley, Richard O., "DARPA Technology Transitions: Problems and Opportunities." Project Memorandum prepared for DARPA. Report Number PM-935-DARPA National Defense Research Institute: June 1999.

John, Vicki L., "Department of Defense (DoD) and Industry — A Healthy Alliance," thesis, Naval Postgraduate School, Monterey, CA. June 2001.

Joint Chiefs of Staff, *Joint Vision 2010: Focused Logistics: A Joint Logistics Roadmap*.

Jones, Jennifer, "Moving into Real Time: Enterprises Can Now do Business with up-to-the-Minute Data Feeds, But Getting All the Pieces in Place May be Challenging," *InfoWorld*. January 21, 2002, Vol. 24, No. 3., p. 30.

Robillard, Lucie, LtCol. *AWACS Reduction Total Ownership Cost*, July 24, 2001.

Merriam-Webster's Collegiate Dictionary at http://www.m-w.com (accessed January 29, 2002).

Morrow, Walter E., Jr., *Summary of the Defense Science Board Recommendations on DoD Science & Technology Funding*, Washington, DC: Office of the Secretary of Defense, June 1, 2000.

National Center for Advanced Technologies, *COSSI 'Executive Roundtable' Independent Assessment*, June 11, 2001.

National Center for Advanced Technologies, An Evaluation and Assessment of the DoD Commercial Operations & Support Savings Initiative: Final Report of the DoD COSSI Program Independent Assessment Executive Roundtable. Report Number 01-CO1A. Washington, DC: September 2001.

National Center for Advanced Technologies, An Evaluation and Assessment of the DoD Dual Use Science and Technology Program: Final Report of the DoD Dual Use Science and Technology Program Independent Assessment Panel. Report Number 00-1A. Washington, DC: June 2000.

National Center for Advanced Technologies, "Toward More Affordable Avionics: An Industry Perspective" Final report of the Affordable Avionics Initiative Working Group. Report Number 01-AAI-1. Washington, DC: November 2001.

National Research Council, Board on Science, Technology, and Economic Policy, *The Small Business Innovation Research Program SBIR: An Assessment of the Department of Defense Fast Track Initiative*. Washington, DC: National Academy Press, 2000.

National Research Council, *Equipping Tomorrow's Military Force: Integration of Commercial and Military Manufacturing in 2010 and Beyond*. Report by the Committee on Integration of Commercial and Military Manufacturing in 2010 and Beyond, Board on Manufacturing and Engineering Design, Division of Engineering and Physical Sciences. Washington, DC: National Academy Press, 2002.

National Technology Alliance, *National Technology Alliance: Accomplishments & Projects 1997–1998*, National Imagery and Mapping Agency, Bethesda, MD: January 1999.

National Technology Alliance, *National Technology Alliance: Strategic Business Areas*, National Imagery and Mapping Agency: Bethesda, MD. No. 042600.

NAVICP prepared for NAVSEA PMS317, *Best Value Opportunity Screening Process (BVOSP)*, April 11, 2001. Government Contracts Service, No. 1701, published by Procurement Associates, Covina, CA: September 15, 2001.

Office of the Deputy Under Secretary of Defense for Acquisition Reform, *Commercial Item Acquisition: Considerations and Lessons Learned*. Washington, DC: July 14, 2000.

Office of the Deputy Under Secretary of Defense for Acquisition Reform, *Incentive Strategies for Defense Acquisitions.* Washington, DC: April 2001.

Office of the Inspector General, *Army Transition of Advanced Technology Programs to Military Applications*. Report Number D-2002-107, June 14, 2002.

Office of Management and Budget, *Use of 'Share in Savings,'* Circular A-11. http://www.whitehouse.gov/omb/circulars/a11/02toc.html.

Office of Management and Budget, *Grants and Cooperative Agreements with State and Local Governments*, Circular A-102. http://www.whitehouse.gov/omb/circulars/a102/a102.html.

Office of Management and Budget, *Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations*, Circular A-110. http://www.whitehouse.gov/omb/circulars/a110/a110.html

Office of the Secretary of Defense Cost Analysis Improvement Group, *Operating and Support Cost-Estimating Guide*. Washington, DC: May 1992.

Office of the Secretary of Defense DDR&E, *Department of Defense Independent Research and Development (IR&D) Program Action Plan*, November 2000.

Office of the Secretary of Defense, "New Challenge Program," *Federal Register*, Vol. 64, No. 71, p. 19744. http://www.mailgate.org/gov/gov.us.fed.dod.announce/ms g01106.html.

Office of the Under Secretary of Defense for Acquisition and Technology, *Report of the Defense Science Board Task Force on Acquisition Reform Phase IV*, July 1999.

Office of the Under Secretary of Defense for Acquisition and Technology, *Report of the Defense Science Board Task Force on Defense Science and Technology Base for the 21st Century*, June 1998.

Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *"Other Transactions" (OT) Guide for Prototype Projects*. January 2001. http://www.acq.osd.mil/dpap/.

Office of the Under Secretary of Defense (Comptroller), *RDT&E Programs (R-1)*, Department of Defense Amended Budget, Fiscal Year 2002 (Modified July 2, 2001).

Pentland, Dr. Pat Allen, U.S. Commission on National Security/21st Century, *Creating Defense Excellence: Defense Addendum to Road Map for National Security (Defense addendum to Hart-Rudman report)*, May 15, 2001. Available at http://www.nssg.gov/addedumpage.htm.

Potomac Institute for Policy Studies, *Transitioning DARPA Technology*. Final Technical Report for the period December 2000 through May 2001. Prepared under contract No. DAMD17-00-2-0033, May 2001.

"Predict Future Process Capabilities" excerpt on technology transition. Now accessible only through search engine at http://www.bmpcoe.org/search1/index.html.

Proteus Group, LLC and Technology Strategies and Alliances, Office of Naval Research Technology Transition Wargame Series: Organic Mine Countermeasures Future Naval Capabilities Wargame. After Action Report, May 28, 2002.

Purdue, Thomas M., "The Transition of ACTDs — Getting Capability to the Warfighter: Demonstrating Utility Is Only Part of the Job," *Program Manager.* March-April 1997, p. 18.

Reduction of Total Ownership Costs: R-TOC Best Practices.

Reduction of Total Ownership Costs: Lessons Learned.

Robert C. Byrd National Technology Transfer Center at Wheeling Jesuit University, *2000-2001 Annual Report*. Wheeling, WV: Robert C. Byrd National Technology Transfer Center.

Smith, Giles, Jeffrey Drezner, and Irving Lachow, *Assessing the Use of 'Other Transactions' Authority for Prototype Projects*. National Defense Research Institute briefing for the Office of the Secretary of Defense, 2002.

Under Secretary of Defense for Acquisition, Technology, and Logistics, "Intellectual Property." Memorandum, December 21, 2001.

Under Secretary of Defense (Acquisition, Technology, and Logistics), "Evolutionary Acquisition and Spiral Development," Memorandum. Washington, DC: April 12, 2002.

Under Secretary of Defense (Acquisition, Technology, and Logistics); and Deputy Director, Defense Research and Engineering, "Technological Superiority for National Security." Statement before the Senate Armed Services Committee, Emerging Threats and Capabilities Subcommittee, Defense Wide Research and Development, June 5, 2001.

U.S. Commission on National Security (USCNS)/21st Century, *Creating Defense Excellence: Defense Addendum to Road Map for National Security*, May 15, 2001

U.S. House of Representatives, *Small Business Innovation Research Program Act of 2000*, P.L. 106-554, Appendix 1 — HR 5667, Title 1. Accessed August 1, 2002, at http://www.acq.osd.mil/sadbu/sbir/pl106-554.pdf.

U.S. Joint Forces Command, *Joint Forces Command Glossary*. Accessed August 4, 2002, at http://www.jfcom.mil/about/glossary.htm#JE.

Wu, Benjamin, Stanley Fry, Richard Carroll, Gilman Louie, Tony Tether, and Stan Soloway. Testimonies about "Intellectual Property and R&D for Homeland Security," at oversight hearing before the Subcommittee on Technology and Procurement Policy, Committee on Government Reform, House of Representatives, U.S. Congress, May 10, 2002.

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