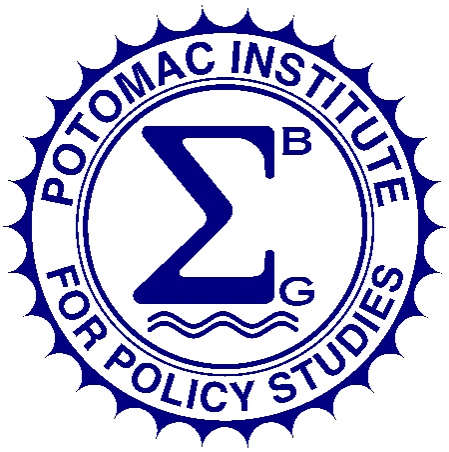
DUAL USE RESEARCH PROJECT REPORT

PIPS-96-3



21 JULY 1996

POTOMAC INSTITUTE FOR POLICY STUDIES
1600 WILSON BOULEVARD SUITE 1200
ARLINGTON, VA 22209

A POTOMAC INSTITUTE FOR POLICY STUDIES REPORT: PIPS-96-3

DUAL USE RESEARCH PROJECT REPORT

MILITARY AND INDUSTRY PANEL

GEN AL GRAY (RET, USMC) — CHAIRMAN
GEN GLENN OTIS (RET, USA)
LTG JAMES CLAPPER (RET, USAF)
RADM WALTER CANTRELL (RET, USN)
DR. ED DAVID
MR. HAL EDMONDSON
MR. HOWARD SCHUE
DR. JAMES J. RICHARDSON, PANEL COORDINATOR

21 JULY 1996

POTOMAC INSTITUTE FOR POLICY STUDIES
1600 WILSON BOULEVARD SUITE 1200
ARLINGTON, VA 22209

May 31, 1997

President

Potomac Institute for Policy Studies

1600 Wilson Boulevard, Suite 1200

Arlington, VA 22209

Dear Sir:

We are pleased to forward the final report of the Dual Use Research Project prepared by our Military and Industry Panel. We believe we successfully met the three major goals you established in your Terms of Reference:

* Assess the military value of dual use to the DOD;
* Determine the commercial value of dual use and how commercial success benefits the military; and
* Suggest ways to implement and conduct dual use programs in the DOD.

The Panel members, with their extensive backgrounds in military operations, business, technology, research, development and acquisition, provided a good balance for this important study effort. It was a privilege to have the opportunity to serve as Chairman of these distinguished Americans.

A.M. Gray

General, USMC (Ret.)

Chairman, Military and Industry Panel

Dual Use Research Project

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Acknowledgment

The Dual Use Research (DUR) Project was conducted under a grant from the Defense Advanced Research Projects Agency (DARPA). The Potomac Institute for Policy Studies and our Military and Industry Panel would like to express our appreciation for the considerable effort on the part of DARPA in making this Project possible. In particular, while they bear no responsibility for the findings in this report, the insights of Dr. Lee Buchanan, Mr. John Jennings, and Mr. Rick Dunn, all of DARPA, were crucial to our understanding of the complex issues addressed.

EXECUTIVE SUMMARY

"IN GENERAL, WE BELIEVE MOST OF THE TECHNOLOGIES THE DEFENSE DEPARTMENT DEPENDS UPON — ELECTRONICS, SEMICONDUCTORS, AND COMPUTER SOFTWARE TO MENTION A FEW — HAVE EQUIVALENTS IN THE COMMERCIAL INDUSTRY. THEREFORE WE DO NOT BELIEVE WE HAVE TO MAINTAIN A DEFENSE-UNIQUE CAPABILITY IN THOSE AREAS."

— DR. WILLIAM PERRY, SECRETARY OF DEFENSE

A. Background.

The Dual Use Research (DUR) Project was initiated under a grant by the Defense Advanced Research Projects Agency (DARPA) to examine issues pertinent to the proliferation of dual use throughout the DoD. It was managed by the Potomac Institute for Policy Studies[1] to address three major goals:

1. **Assess the military value of dual use to the DoD**
2. **Determine the commercial value of dual use and how commercial success benefits the military**
3. **Suggest ways to implement and conduct dual use programs in the DoD**

The DUR Project centered on a Military and Industry Panel (hereafter referred to as "MIP," or "Panel") composed of experts in matters relevant to dual use (See Annex A for Terms of Reference). The Panel was supported by a Research Team, which gathered and processed pertinent data and information (See [1]).[2] Panel members were:

Gen Al Gray (Ret, USMC) — CHAIRMAN
GEN Glenn Otis (Ret, USA)
LTG James Clapper (Ret, USAF)
RADM Walter Cantrell (Ret, USN)
Dr. Ed David
Mr. Hal Edmondson
Mr. Howard Schue

This report describes the DUR Project approach, conclusions, and findings — reinforced by a summary of the data and analysis that support them. The conclusions and findings reflect the Panel's assessment of the value of dual use and suggest options for proliferating and embedding a dual use culture throughout the DoD. The conclusions and findings rest upon data and insights derived from the collective industry and military service experience of the Panel members, general studies of dual use, and examinations of DARPA's Technology Reinvestment Project (TRP). Data and information from subsidiary work by the DUR Team were widely employed by the Panel and are contained in several publications listed in Annex B.

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1 The Potomac Institute for Policy Studies is a not-for-profit organization dedicated to the development and support of non-partisan analysis of technology and technology policy. The Institute has conducted studies that provide insight into the impact of new technologies on our society, the proper relationship between government and industry, and the future of the US industrial base.

2 Throughout this report, numbers in square brackets, [ ], will refer to these and other references found in Annex B.

B. Purpose and Definition of Dual Use.

The purpose of dual use is to gain improvements in military systems' affordability, functionality, and availability through the exploitation of commercial research, technologies, processes, products, best practices, and economies of scale. Congress provided a definition of dual use in 10 U.S.C. 2491:

"Dual Use, with respect to products, services, standards, processes, or acquisition practices, means products, services, standards, processes, or acquisition practices, respectively, that are capable of meeting requirements for military and non-military application."

In applying this definition, it is important to distinguish between "Dual Use Products" and "Dual Use Approaches."

"Dual Use Products" refers to dual use products, processes, technologies and research findings, and includes Commercial-Off-The-Shelf (COTS) equipment (applicable for military use without modification) and Non-Developmental Items (NDI) (commercial products that require modifications, but no development effort, to serve military purposes). These flow from the programs that employ "Dual Use Approaches," which are defined as the standards and acquisition practices used to guide programs such as the TRP and various dual use insertion initiatives in the DoD.[3]

These definitions are important in eliminating apparent contradictions arising from discussions of government/industry co-development of COTS equipment or NDI products. There will, for instance, be occasions — such as the technology co-development programs sponsored by the TRP — where government help is warranted in the development of a non-developmental, or a commercially-viable "Dual Use Product." Of course, the justification of doing so must always be based on projected benefits to the DoD.

C. TRP Lessons Learned.

The TRP Annual Report [2] and reports compiled by the DUR Team ([3], [4], [5], and [6]) aided the Panel in forging several important lessons from the TRP. These, and other lessons discussed in Section III, enabled the Panel to reach final conclusions and to propose an implementation plan.

1. **Products must be tested in their military context.**
2. **Industry involvement was driven principally by the commercial marketplace.**
3. **Military needs must dictate program choices and optimization.**
4. **The TRP could not have been done without innovative contract vehicles.**
5. **The cost share option is essential to TRP development programs.**

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[3] These definitions will be used throughout this report to distinguish between approach and product. It should also be emphasized that in this context, "Dual Use Product" refers to dual use products, processes, technologies and research findings.

6. More program stability is needed, *particularly in support of commercial goals.*

D. Major Conclusions.

The Panel reached several conclusions based on its study of dual use, briefings received, publications, and an analysis of the TRP. Fundamental to these conclusions is the view shared by all members that, although the DoD will continue to need some industries and laboratories to produce defense-unique items, reliance on commercial products must increase. As defense budgets continue to decline, the DoD can only meet its needs, to the greatest extent possible, through the exploitation of commercial research, technologies, processes, and products available from a technologically advanced and growing commercial sector.

Listed below are the major conclusions of the Panel. These findings are expanded and discussed more fully in Section III.C:

1. Dual use can make major improvements in warfighting capabilities and affordability of military systems – and it is faster.

2. Commercial success is crucial to maximizing military benefits through dual use.

3. The dual use process is essentially opportunity-driven.[4]

4. Dual use applies to all phases of the product development life-cycle, from research to insertion. And it can create new programs and Dual Use Products that would not otherwise happen.

5. It is time to broaden the Dual Use Approach, and to apply it throughout the DoD. *This requires a strong mandate from the Secretary of Defense, BUT, it cannot be done simply by decree – an implementation arm is needed.*[5]

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[4] Dual use can be successful only if the DoD adopts a mind set to seek out or create a good opportunity environment for the military. The DoD must ensure relationships with industry that will yield applicable technologies, products, and eventual insertion.

[5] The TRP made significant progress in establishing a new way of doing business. What is needed now is a strategy to firmly entrench dual use into all stages of Military Services' acquisition.

E. A Dual Use Strategy.

The following three-step strategy, discussed in detail in Section IV, forms the credo for a successful integration of Dual Use Products into the DoD:

1. **In a "make or buy" decision:**[6]
   a) **"make" should be the last resort, while**
   b) **"buy" should be the rule, when possible.**
2. **If no commercial product adequately addresses a military concept-based need, try to change the concept to accommodate commercial solutions.**

- Or -

3. **Introduce a third option, the "co-development of dual use technologies or products" through a joint effort with industry.**

F. Implementation.

The **intent** of the proposed implementation effort, described in detail in Section V, is to "normalize" the employment of dual use throughout the DoD. The focus of effort is to teach all concerned about the military benefits of dual use by involving people at all levels in comprehensive formal education and training courses, as well as on-the-job-training. The implementation effort must respond to two challenges. The first is to disseminate knowledge in organizing and conducting dual use technology development programs. Much of this knowledge, gathered during the TRP and other dual use technology development programs, is already resident within DARPA, but new insights are needed to determine the best ways to perform these functions inside the Military Services. The second challenge is to learn how to effectively conduct dual use technology and product insertions into military systems. Less experience is evident in this very important arena and much innovation will be needed. It is important to note that this second challenge must involve the weapons systems prime contractors.

<u>This implementation process is a transitional effort and should have a lifespan of three to five years.</u>

It is vital that the DoD implement dual use decisively. Five important principles guided the formulation of this plan:

1. Dual use can make major improvements in warfighting capabilities and affordability of military systems. The Panel's principal conclusion emphasizes the importance of a strong implementation plan. The body of this report provides evidence of the crucial benefits to be gained through jointure with the commercial sector.

2. The changes required to conduct dual use programs in the DoD are profound and, in many cases, are counter-cultural. New skills and attitudes must be cultivated in the DoD Services and Agencies in order to effectively perform functions required by the Dual

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6 "Make" is defined as the acquisition of defense-unique products designed and produced by defense laboratories and industries. "Buy" implies an acquisition of commercial products, processes or technologies.

Use approach. These functions include **searching** the commercial sector for Dual Use products suitable for the military, **trading off** desired military characteristics for commercial affordability and product support, **negotiating flexible agreements** without burdensome regulations, and conducting the resulting program or insertion in partnership with industry. Performing these functions under the constraints of existing defense acquisition system attitudes and procedures will be inefficient and frustrating - **it will not work!**

3. The most effective way to embed dual use in the DoD Services and Agencies is to implement it through a strong policy statement coupled with a joint Service implementation arm. Active support is needed from the highest echelons of DoD, coupled with an implementation arm, which the Panel has called the Joint Dual use Implementation Office (JDIO). A Secretary of Defense policy directive is needed to emphasize the importance of dual use to the DoD and to establish the components of this implementation plan.

The directive should appoint a Senior Dual use Board (SDB) to oversee the implementation and to set policies and review proposed targets for dual use programs. Under this plan, the SDB will be co-chaired by the Undersecretary of Defense for Acquisition and Technology [USD(A&T)] and the Vice-Chairman of the Joint Chiefs of Staff. The SDB will consist of the Service Vice Chiefs of Staffs to ensure that operational requirements are addressed and other members deemed appropriate by the USD(A&T) to address acquisition policy. Industry participation should be considered.

The JDIO will teach participants from government and industry to use the basic "dual use tools," through formal training and education. It will also demonstrate the Dual Use Approach and the military benefits of that approach *through sponsoring dual use efforts*. The Defense Systems Management College (DSMC, Ft. Belvoir) would be an excellent place to begin teaching upcoming program managers of the benefits and techniques of dual use. A strong curriculum package in dual use should be added to the current regimen at DSMC.

The military benefits of dual use will be accomplished by encouraging and guiding the formation of Service "Tiger Exploitation Teams"[7] to find, propose, and conduct dual use efforts. In this way, dual use will be performed under the guidance of the best dual use experts in the DoD, housed in the JDIO, while "the action and the learning" will occur in the Services and outside of both the JDIO and the normal acquisition process. The JDIO will provide funding to seek out prospective Dual Use Approaches that are specifically tailored to leverage the commercial sector. The JDIO will also report progress and make recommendations to the SDB in order to improve the effectiveness of dual use programs and policies. New lessons should be passed across to the Services and up to the SDB. These lessons should be quickly incorporated into policy and regulation documents at all levels in order to educate and to empower DoD acquisition officials to employ dual use throughout the spectrum of defense business.

The purpose of this implementation effort is to enable, motivate, and accelerate Military Service and Agency efforts to adopt dual use as the principal precept of their day-to-day operation. Therefore, the JDIO leadership role is "facilitator," rather than "Czar" --- **action-oriented leadership to make it happen**! Successful execution of the aforementioned effort requires funding that is distinct from that currently authorized, appropriated, or planned for ongoing Service research, development and acquisition efforts. *Thus, funding should be provided as a separate*

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7 Tiger Exploitation Teams, suggested by the 1995 Defense Science Board Summer Study, are essentially Integrated Product Teams (IPTs) that could be led by a project office, a User, DARPA, or the Laboratories.

line and not derived by taxation of ongoing, established DoD programs. As dual use becomes "normalized" throughout the DoD and is embedded in all phases of the acquisition process, this transitional funding will "sunset" (in 3-5 years) right along with the organization — the JDIO.

4. The implementation effort should work toward incorporating dual use practices throughout all phases of the product development cycle. The implementation effort must be sufficiently extensive to make a difference. The multi-faceted activities currently underway in the OSD are natural and valuable components of this more broad-based dual use implementation scheme. All aspects of dual use should be brought together under one roof. Thus, the JDIO and the Tiger Exploitation Teams can operate with a consistent approach across the spectrum of the product development cycle, from research to insertion, to deliver Dual Use Products at every stage of development into the DoD. This approach expands the scope of available options to allow an integrated thought process coupled with a rigorous analysis of trade-offs among acquisition strategies, e.g., between co-development and direct insertion of a product.

5. It is the judgment of the Panel that, with education and training and a change of culture, dual use should evolve into the primary mode of development and procurement in the DoD.

DUAL USE RESEARCH PROJECT

FINAL REPORT

"The national security of the country will hinge increasingly on the use of commercial technologies and equipment for military purposes. This is the only feasible way for the Department of Defense to avail itself of the best technology and products in a timely and affordable way."
Dr. Ed David, Military and Industry Panel Member.

SECTION I.
INTRODUCTION

A. Outline of Report

This is the final report of the Dual Use Research (DUR) Project. The Project was performed under a grant by the Defense Advanced Research Projects Agency (DARPA) and managed by the Potomac Institute for Policy Studies[8]. Its purpose was to examine issues pertinent to the proliferation of dual use throughout the DoD.

The report is divided into five sections, the first of which provides background information, the setting in which the study takes place, and some definitions used throughout the report. Section II presents the objectives and methodology of the DUR Project and discusses the sources of data used to support the work of the Panel. Section III provides the major conclusions and findings of the Project, including lessons learned from DARPA's Technology Reinvestment Project (TRP) and conclusions on dual use in general. Section IV proposes a strategy to maximize the insertion of commercial products into the military. Finally, Section V offers a plan to implement dual use throughout the DoD.

B. Background

The DoD has been in the dual use business for years, spending a large portion of its annual procurement budget on commercial items. Examples of COTS equipment or NDI regularly purchased by the military are numerous. The Army's Commercial Utility and Cargo Vehicles (CUCVs) are essentially purchased directly from the production lines of the "Big Three" car manufacturers and put into service. Military mess halls around the world routinely buy produce and other foodstuffs from commercial sources. Paper products and items of clothing are bought from the catalogs of commercial manufacturers. Despite this, there are many important areas where the full benefit of commercial products and technologies is not being realized. These failures to take advantage of the commercial marketplace will become more costly as the commercial sector grows in capacity to develop and produce, while the military R&D budget and infrastructure both shrink.

And so the backdrop for this study is a rapidly changing balance in capacity and influence between the commercial and defense R&D sectors. The growth of the former, spurred by global competition, is generally accepted. But it is worth reviewing the magnitude and nature of this phenomenon, since this facet of the defense environment will shape most of the DoD's future acquisition options.

Conventional defense technology development programs have properly placed great emphasis on producing technologies and products designed solely to meet specific military needs. Times are

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changing, however, and there are new circumstances, needs, and opportunities to consider in budgeting for defense that were not present ten short years ago — and new strategies are needed to address them. Reliance on commercial products will grow for reasons discussed below, even though defense will continue to need industries and laboratories to produce defense-peculiar items.

1. Advanced technology remains key to US military success. Although there will not be a large, Soviet-style threat in the near future, potential regional conflicts and instabilities will require a strong and flexible US military capability. This strength will continue to rely heavily on the development and employment of advanced technology.

2. Defense specific R&D and procurement have become extremely expensive and the DoD budget is in decline. R&D and production costs under defense procurement regulations make military-unique products expensive when compared to Dual Use Products. There are many examples of this, such as the Global Positioning System (GPS) made available for Desert Storm. The military version, originally sought, would have cost the government $34,000 for each unit and would have required approximately 18 months for delivery. Commercial models, with a few performance trade-offs, but weighing about one-sixth as much as the military version, were bought instead, at a unit cost of $1,300 and with immediate delivery [7].

On a higher level of comparison, US defense R&D spending has grown by about 50% since 1960, but US commercial R&D has grown by more than 400% over the same period [8], as shown in Figure 1.[9] The much larger commercial R&D outlay is aimed at commercial-market productization. If defense is to take advantage of it, then the DoD must become involved, as *any* customer should, to ensure that its particular needs are met. Even though DoD R&D budgets are falling, defense remains many times more R&D-intensive than the commercial sector. "For defense, R&D is 31% of the total acquisition (procurement plus R&D) budget, whereas in civil manufacturing as a whole the corresponding ratio of R&D to sales is less than 5%." [8] In this environment, it just makes sense that dual-use practices in the military must become increasingly proactive in order to leverage the available funding by exploiting commercial material, processes, and technologies through pervasive dual use practices.

9 Of even greater importance, the DoD budget has decreased by 7.2% between 1989 and 1994, while the GDP has grown by 28.3% (see Annex E).

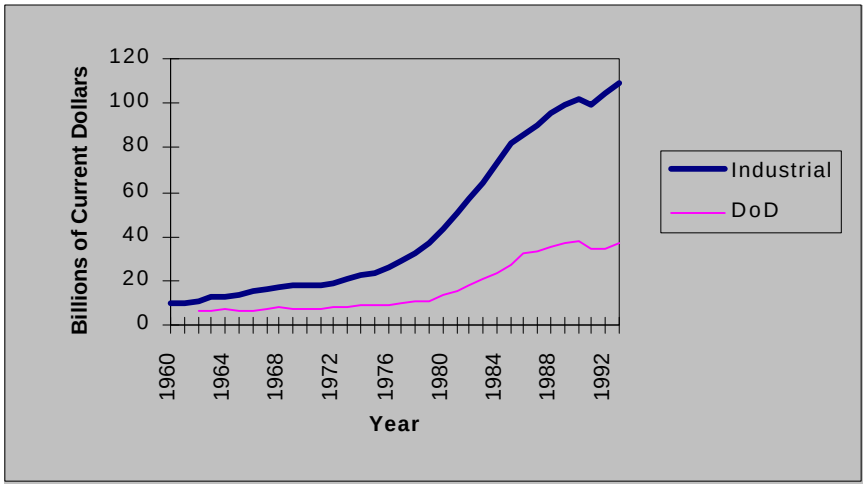

FIGURE 1. DOD R&D VS COMMERCIAL R&D

Military procurement budget levels are also in decline. This has further reduced the viability of many remaining defense-unique industries and facilities. The DoD is losing much of the captive defense industry which has served it over the past 50 years. An additional ramification of lower defense procurement levels, exacerbated both by lower procurement levels and unprecedented growth of the commercial market, is that DoD represents a progressively smaller percentage of the overall market.

This is particularly true of the electronics industries. As a specific example, the story of integrated circuits (ICs) forcefully illustrates these trends [8]. After the development of the integrated circuit at Fairchild and Texas Instruments in the 1950s, the technology was given a strong boost by the government's interest in utilizing ICs throughout military systems. By 1965, the DoD accounted for 72% of the IC industry's $85 million market (see Figures 2 and 3 [note that the vertical scale in Figure 2 is *billions* of dollars]). Given the defense impetus, the semiconductor industry flourished, creating the considerable consumer and industrial markets for IC technology throughout the 1970's and 1980's and resulting in a market of $17.8 billion by 1990. However, during those years the DoD's use of ICs was principally in special-function applications with procurements constrained by MILSPECs. The net result was that, despite the strongly increasing importance of ICs to military systems, the DoD could not reap the full economic benefits of commercialization (e.g., economies of scale) in an industry it had helped grow. By 1995, the DoD demand for ICs had dropped to only 1-3% of the total market. The net result today is a limited DoD buying-power influence over the semiconductor industry. Moreover, those components the DoD does purchase continue to be overwhelmingly constrained by military specifications and requirements for function and performance, resulting in greatly increased costs to the government.

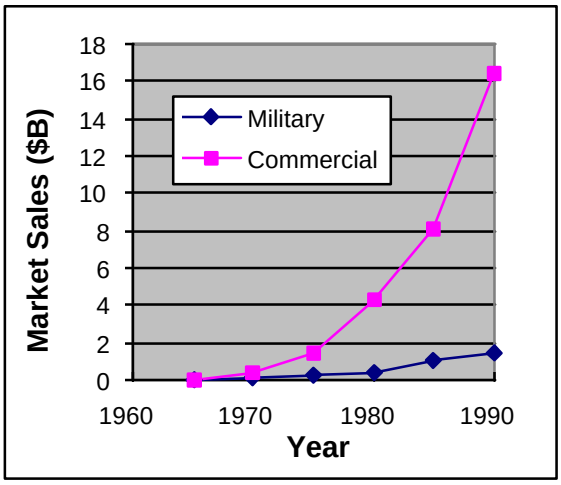

FIGURE 2. MILITARY AND COMMERCIAL IC MARKET SALES [REF 8, CHAPTER 8]

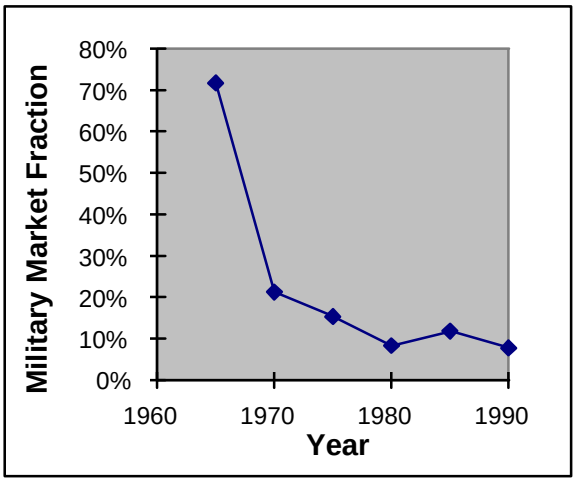

FIGURE 3. MILITARY FRACTION OF TOTAL IC MARKET SALES [REF 8, CHAPTER 8]

3. The best and most affordable technology and products are now often found in the commercial sector. With increasing demands by the global customer base for reliability and performance, best commercial practices may often lead to better products than military specifications. The sheer size and momentum of the commercial sector, coupled with the pressures of international competition, will ensure that it continues to outstrip the defense sector in affordability and, to an increasing degree, quality and reliability. When DoD successfully leverages the commercial sector for key items, it also gains the incorporation of new technologies for product improvements, which the commercial sector incorporates into each new generation of products.

4. Readiness and modernization concerns will grow with time and vie for R&D funds. Further, as funds dedicated to modernization decrease, system upgrades, rather than new systems development, will likely become the rule. Evolutionary product improvement demands continuity of the manufacturing and service base for the item of equipment in question. It also requires attention to protocols and standards to ensure compatibility of new components, software, or add-on units. While the commercial world is comfortable with these concepts, defense industry has had trouble performing upgrades efficiently and cost effectively. This is particularly true for long-term buyouts, such as the M1-series tank, which will have been in production for nearly fifty years at the planned buyout date.

C. "Dual Use" Definitions and Mission

1. "Dual Use" Definition. Section I. B described the circumstances under which this Project was conducted. Before discussing Project objectives of the Project and approach, definitions must be developed for dual use and the Technology Reinvestment Project. A formal definition of dual use, taken from Congressional language under 10 U.S.C. 2491, was adopted for the DUR Project:

"Dual Use, with respect to products, services, standards, processes, or acquisition practices, means products, services, standards, processes, or acquisition practices, respectively, that are capable of meeting requirements for military and nonmilitary application."

It bears repeating that this report makes a distinction between "Dual Use Products," and "Dual Use Approaches." The former include products, processes, technologies and research findings that are Commercial-Off-The-Shelf (COTS) or Non-Developmental Items (NDI). These flow from programs conducted under the "Dual Use Approach," which are the standards and acquisition practices used to guide programs (such as the TRP and various dual use insertion initiatives in the DoD.) These definitions are used throughout this report to distinguish between approach and product. It should also be re-emphasized that, in this context, a "Dual Use Product" may be a product, process, technology or research finding. Hopefully, these definitions will eliminate apparent contradictions arising from discussions of government/industry co-development of COTS or NDI products, since there will be occasions where government help is warranted in the development of a product which, when brought to the marketplace, will also serve the government without further development (i.e., a commercially-viable "Dual Use Product"). Of course, the justification for doing so must always be based on projected benefits to the DoD.

2. The Technology Reinvestment Project (TRP). The TRP was a DoD program, managed by DARPA, to develop Dual Use Products that satisfy both defense and commercial requirements through innovative partnerships, and cost- and risk-sharing with industry. The DUR Project extensively examined that portion of the TRP dedicated to technology development. In the early phase of the TRP, there were also programs conducted in technology deployment and manufacturing education and training. The total funding distributions for these three areas were $846M for technology development, $233M for technology deployment, and $60M for manufacturing engineering education technology. The latter two program areas were discontinued primarily because some in Congress doubted their relevance to military needs.

3. Purpose of Dual Use in the DoD. The purpose of dual use is to gain improvements in military system performance, affordability, and availability through the exploitation of commercial research, technologies, processes, products, best practices, or economies of scale.

SECTION II.
DUAL USE RESEARCH
PROJECT APPROACH

A. DUR Project Objectives

The DUR Project addressed three objectives, each of which had several affiliated issues that are described in the next few paragraphs.

1. Assess the military value of dual use to the DoD. The first objective of this study was to judge the worth of dual use to the DoD. This judgment enhances the ability of DoD officials to make informed decisions concerning the commitment of scarce DoD resources toward the proliferation of dual use — decisions which must be made in the face of hundreds of other issues scrambling for priority on DoD's attention manifest. In simple terms, the Panel distilled this to a question of determining the significance of unexploited dual use opportunities in enhancing our Nation's warfighting capabilities. How many Dual Use Products are still out there waiting for purchase or investment by the DoD, and what is the total value of this "hanging fruit?" These were difficult questions for the Panel to answer quantitatively, since much of what is available from literature, case studies, and briefings received by the Panel are anecdotal in nature.

2. Determine the commercial value of dual use and how commercial success benefits the military. Although dual use technologies and products should clearly emphasize military benefits, they must serve commercial goals as well in order to interest industrial participants and to gain subsequent advantages for defense. In pursuit of this objective, the Panel studied the balance which must be maintained between these two product goals in order to bring optimal returns to the military.

3. Suggest ways to implement and conduct dual use programs in the DoD. There seem to be ample opportunities to import commercial technologies into the DoD. If so, why aren't we doing more of it? Is it due to ineffective procedures, restrictive regulations, or simply the difficulty of overcoming the inertia of a large bureaucracy? Perhaps even more important, how can we pursue dual use in a more effective manner? This last question received much of the Panel's attention. Part of the answer, offered in Section III, lies in how to conduct individual dual use programs. A second part, discussed in Section IV, concerns the development of a basic acquisition strategy, prioritizing commercial "buy" decisions.

Structuring a dual use organization to support effective decision-making and program management is a major challenge. In order to address this objective, Dual Use Approach issues were defined and investigated, principally through an examination of the TRP. The TRP provided a wealth of data and experience that could be viewed from several perspectives, including those of TRP management personnel, industrial participants, and the Military Services. This investigation addressed a number of sub-issues concerning the Services, the structure of the programs, and the detailed Dual Use Approach under which the TRP was conducted. These sub-issues are listed below, while relevant conclusions are reported in Section III.

One sub-issue studied was the process of choosing which technologies to pursue, who should participate in the selection (e.g., DARPA, the Military Departments and Services, industry), and

how that participation should be managed. In a broader context, since military utility must be the principal concern, an inherent part of this sub-issue must be how User needs are represented in selecting programs to pursue and in resolving necessary tradeoffs between commercial and military roles of the final products.

Another important sub-issue lies in the choice of conducting the program as a multi-Service effort, as opposed to distributing the resources across individual Service programs. The merits of a centralized effort with greater economy of scale, collective management, concentrated skills, and an ability to represent dual use efforts as a whole, were considered in light of the drawback of adding bureaucracy.

In the TRP, non-DoD agency participation was mandated. While personnel from different agencies added insight and breadth to the effort, some questioned whether their participation diluted the military focus.

Various aspects of the Dual Use Approach were also considered by the Panel, such as: fairness in the selection process; innovative non-procurement agreements; requirements for partnerships and consortia; cost sharing; allocation of intellectual property rights; multinational corporation and market involvement, and representing a dual use program to the DoD, industry, Congress and the public.

If it is true that dual use is useful to the military, if its employment should be expanded, and if there are optimal ways to conduct dual use programs, how should the DoD implement a new dual use thrust? In Section V, the Panel offers an implementation strategy to embed dual use throughout the DoD at all levels of the acquisition system.

B. DUR Methodology

The DUR Project was organized around a Military and Industry Panel, with a Research Team to collect and process needed information and data. The Project was conducted in four overlapping phases. The first two phases collected information concerning the objectives discussed above. Phase 1 extracted pertinent information from publications and dual use programs other than the TRP to produce a survey paper [3]. During Phase 2, the Research Team collected and analyzed data from the TRP. From this input and information from other sources, the Panel forged lessons learned from the TRP. During Phase 3, findings from the first two phases were synthesized into options to improve the dual use process, under a planned DoD initiative. Finally, in Phase 4, the Panel and Research Team conducted follow-on activities, such as consultations with DoD and industry leaders and briefings of final conclusions and suggestions. This methodology is described in more detail in the DUR Project Plan [1].

1. Phase 1: Dual Use Survey. The DUR Team and the Institute for Defense Analyses (IDA) collected a considerable body of reports and papers on dual use technology development, its past contributions to the military, its effects on commercial and defense industry, and new concepts and ideas on how it should be conducted. From this body of literature, IDA wrote a survey report [3], which captured pertinent conclusions from the literature on the general subject of dual use.

2. Phase 2: TRP Lessons Learned. The TRP is the largest dual use technology development effort ever attempted by the DoD. Since the TRP began in FY92, it has held three solicitations and is currently sponsoring over 130 technology development programs. Continued management of these programs will be required for about two more years. The TRP experience represents an extensive body of data which the Panel employed as a source of information to investigate the viability of various means of conducting programs in dual use technology development.

The principal outputs of this phase are the lessons learned from the TRP experience. These were drawn from interviews with military users, case studies [4], questionnaires [5], and the TRP Annual Report [2]. Lessons learned are presented in Section III. Since final products from the TRP will not be forthcoming for some time, it was necessary to draw many lessons from incomplete returns — to substitute extrapolation for hard data. Although investigations undertaken during this phase were constrained to the TRP, the resulting lessons were applicable to dual use in general.

The Project pursued three areas of investigation during this phase:

a) Review of TRP Working Group Records. Documents and files maintained by the TRP Working Group contain historical data on every facet of the TRP. Solicitation announcements, outreach literature and briefings, proposal counts, evaluation criteria and results, program agreements and milestones, and remarks and trip reports by program managers and Working Group staff members are among the records of interest. Data extracted from these records were used principally to compile statistics on the effectiveness and comprehensiveness of the TRP process. These data are found in reference [6].

b) Examination of Individual TRP projects. A large component of the lessons learned reflect good and bad experiences at the individual program level. This effort examined how TRP procedures affected these programs and their products. While robust methodologies do not yet exist to support forecasting the effects of new technologies to desired accuracies, it was felt that an assessment of the TRP should include both a review of the progress and evolution of the individual technology development programs to the present and an extrapolation of future performance. These inquiries also questioned the impact of government-mandated rules and processes on the outcome of the programs.

1) Case Studies. The Research Team conducted case studies to examine the histories and plans of individual TRP programs as they relate to the appropriateness, effectiveness and efficiency of both the dual use process and the emerging products. Specifically, the investigation focused on whether the TRP programs are structured to meet both military and commercial goals and on the projected military suitability of technologies and products being developed. Both positive and negative findings were incorporated. Although case studies concentrated on the perspective of the participating industries, interviews were also conducted with government program managers and users of the program products. For details on the case and selective studies, see reference [4].

2) Questionnaires. In order to access a larger population than was possible through the case studies, the Research Team sent a questionnaire to all companies participating in individual TRP technology development programs. The chosen questions were expressed in a manner that allowed statistical compilation. They addressed selected issues where a sample size larger than the case studies would allow was needed. The questionnaire questions and responses are found in reference [5].

c) Military Service and industry Interviews. The Panel interviewed Military Service and industry leaders to obtain their perspectives on both the TRP and dual use. In this way, interviews solicited opinions on both dual use and on how well the TRP fulfilled its role as a dual use program. Findings derived from these interviews, and direct (but unattributed) quotes are offered in Section III and Annex C, respectively.

3. Phase 3: Synthesis and Modeling. Conclusions and recommendations were developed by the Panel during this phase and were embodied in a final report and briefings. The Panel accomplished this over approximately three months through data analyses, discussion and input from industry and government leaders.

4. Phase 4: Follow-On Activities. Upon completion of the proposed study, the Panel and Research Team began several follow-on tasks:

a) Studies of maturing TRP products. Many technologies and products being developed under the TRP are just beginning to reach maturity. Within the next year, it will be possible to gain some important insights into how well these products will fare in both the commercial and military worlds.

b) Panel support of Service and industry involvement. The Panel has presented its conclusions to industry and government and helped in planning and encouraging the participation of the military Services and industry in the next generation of dual use programs.

c) DoD dual use initiative. If dual use funding is approved for FY97, the recommendations of the study should be used to help in organizing any new DoD dual use initiative.

SECTION III.
MAJOR FINDINGS AND CONCLUSIONS

A. TRP Lessons Learned

The Panel felt that the Technology Reinvestment Project could serve as a "laboratory model" to provide many valuable lessons that must be heeded when framing a broader dual use policy that expands to embrace (i) integration of commercial and military R&D and production, and (ii) the insertion of products, processes, and technologies into the military. A summary of the lessons the Panel learned from the "TRP experience" appears below.

1. Dual use products must be tested in their military context. TRP products are generally too immature for their final performance to be accurately judged at this time. Most products have undergone some testing, often only at a component or proof-of-principle level. In general, they have fared well in test. Few consortia felt that their products required special military testing beyond the tests prescribed by the commercial market, citing increasing demands for product reliability and performance by the modern consumer. However, in the absence of military specifications, it is vital to demonstrate the military utility of dual use "products" through selective laboratory and troop testing.

2. The commercial marketplace is a principal motivation for participating industries. The TRP industry involvement and investment is driven principally by the commercial marketplace. From the case studies and questionnaires, it was obvious that most consortia had given deep thought to the commercial marketplace and to its potential customers. They depend upon the commercial, rather than military, market for economic success. Yet, most of the consortia indicated that they would not have undertaken their programs (at least to the magnitude of the TRP effort) had it not been for government involvement, encouragement, and cost sharing. The principal lesson to be learned here is that the industrial partner should be allowed to pursue the commercial marketplace. An important secondary lesson is found in the realization that government can have a major influence on the willingness of commercial industry to pursue, or pursue more robustly, a product development.

3. Military needs must dictate program choices and optimization. The TRP Annual Report [2] and the DUR Project TRP case studies and questionnaires ([4] and [5]) provide evidence that each industrial consortium had also given much thought to the military use of its products and that individual programs addressed important military needs. A study performed by the Institute for Defense Analyses also concluded that there was acceptable military relevance to the programs, as did a year-long General Accounting Office (GAO) investigation.[10] Most programs investigated in the case studies, and most of the responses to the DUR questionnaires, cited a military need, but seldom had this need originated with, or been articulated by, the operational user. This was true even though the products were generally mature enough to demonstrate their

[10] "Technology Reinvestment Project, Process, and Outcomes of the 1993 Competition," GAO Code NSIAD-905-99-705032 (June, 1995)

function quite well (at least at a conceptual level). The Panel believes that it is particularly important for dual use efforts, which are often struggling to meet commercial as well as military goals, to establish early and close relationships with the military user, integrator, or developer of the product. This will assure that military needs dictate the program's choices and optimization and that a clearly enunciated insertion strategy is developed early and updated as needed.

Even so, the Panel felt that many of the Focus Areas in the TRP were particularly well planned, with a clear connection to the user, addressing an area of technology or capability needed in a holistic way. Some of the TRP programs exemplifying this degree of planning were Casualty Care, Electric Hybrid Vehicle, and Digital Wireless and Communications Systems [2]. Each of these areas has an overall user-oriented goal, with a well-defined development path.

4. Multi-Service aspect should be strengthened. The benefits of a multi-Service program in dual use include: (i) a broad application across all Services; (ii) consistency of approach and policies; (iii) organizational economies of scale, and (iv) a concentration of expertise and upper-management support, (v) while reducing duplication of effort (see [2] for evidence of the diversity of the TRP and its participants). On the other hand, there was an obvious need for the TRP to attract a more active involvement by the Military Services in order to justify its claim as multi-Service. This problem was central to the development of the Panel's implementation plan discussed in Section V.

5. Non-DoD agency participation should be sought on a case-by-case basis. Although non-DoD agency participation was sometimes beneficial, it should be sought only on a case-by-case basis. Few case study or questionnaire responses suggested that non-DoD agency participation was important, but there were favorable comments from the TRP Working Group on the help rendered by these agencies. It may make sense to involve non-DoD agencies where there is a clear area of common interest and expertise (e.g., DOJ for OOTW/Law Enforcement, DOE for electric vehicles).

6. Innovative agreements are crucially important. Non-procurement agreements, such as Cooperative Agreements and "Other Transactions" are a necessary tool when seeking flexible negotiations, particularly concerning issues of intellectual property rights and foreign participation. These vehicles can offer a much less burdensome and more creative arrangement between the government and the performing consortium than can conventional contracts. In theory, they allow the essential points of the proposed effort to be negotiated, rather than having terms dictated to all parties by the FAR and other federal regulations.

However, even though the Panel felt that TRP's rules on intellectual property rights (IPR) were on-target, they still caused problems during negotiation. Key among the IPR "sticking points" was industry's strong resistance to what they saw as a history of government "annexation" of privately developed proprietary information as a contractual condition of partnering in a dual-use effort.

The Panel emphasized that the DoD must recognize the realities of the global marketplace in which we now live. Clearly, some excellent dual-use technology initially developed by the US is now widely produced and available overseas. An example from the US Integrated Circuit industry, taken from a 1989 DSB study [11], illustrates the point: In 1989, about 75% of all MIL SPEC ICs were produced by 53 plants owned by 10 US vendors in 15 countries; 12 plants in the US produce the remainder — yet even in those plants, most piece parts (other than the die) are produced by non-US manufacturers. It is often very difficult to distinguish between foreign firms and international US corporations. Hence, it is incumbent on the DoD to avail itself wherever

possible of important dual-use technologies developed by either our Allies or by foreign divisions of US-owned multi-national corporations.

It is now beyond question that globally available technology is available to our potential adversaries. But the US may no longer hope to "bottle the tech-genie" and attempt to develop DoD-specific technology indigenously at great cost in time and money. The DoD must change its perspective and recognize that "Those who do dual use best will maintain the leading edge in military capability." Specifically, this means that the key to maintaining our technological military advantage lies in minimizing our technology development "cycle times" and maximizing our utilization of commercial products, technologies, and processes —in allowing US firms to seek the best business solutions to technology problems (within legal and national security constraints). Innovative agreements are key to allowing this facet of a dual use program to be negotiated.

7. Consortia should be encouraged, but not mandated. Congressional language dictated the formation of industry-led consortia or partnerships for all prospective TRP programs in order to enhance US global competition and to encourage sharing of skills and techniques between defense and commercial industries. Case studies verified that the latter goal was achieved in many instances. For example, representatives of commercial companies on the consortia guided market decisions of their defense industry partners. While consortia and partnerships were found to work well in the TRP programs, discussions with TRP participants clearly indicated that consortia should not be mandated, but their formation should be left to the discretion of the proposers —the government should not dictate to business how to form and structure their teams.

Moreover, structure and leadership is sometimes lacking within the consortia. Case studies revealed that, often, one consortium member simply assumes the leadership role (after deadlocks have hindered the program), but, having done so, finds he lacks the power to perform even minimal leadership roles (such as auditing program funds). This leadership authority should be built into the consortia agreements, when required.

8. Cost sharing should be demanded for technology development programs. Cost share seems necessary for a technology development effort like the TRP, since the DoD will nearly always require an indication of commitment and good intent by industry before deciding to co-develop a technology or product. The benefits of cost share for a developmental program are a reduction of program cost to the government and an assertion by the participating company that the end product will be competitive in the commercial marketplace. A fifty percent cost share is a good floor level for industry contribution.

9. Program stability should be improved. Complementing the cost-share issue is the fact that industry, too, must feel assured of the *government's* commitment and good intent to follow through with the programs which it has selected. Assuming, of course, that the program goes according to plan, most consortia indicated that greater overall fiscal stability is needed if they are to succeed in sustaining the interests of their respective boards of directors. Committing to corporate objectives and justifying the progress of a program to corporate management over several years requires demonstrated continuity and commitment on the part of the government as the cost-sharing partner. Uncertainty about government's assurance of its out-year funding raises questions at the corporate level about a program's legitimacy and the wisdom of continuing corporate support. The Panel felt that the first course of action should be to enter into multi-year agreements and funding. Above that, the government must cultivate a reputation for steadfastness in these programs.

10. The TRP selection process is a good model for future technology development efforts. The Panel agrees with the GAO, which, after a year of investigation, found that TRP solicitations and selections were fairly conducted.[11] While there were many TRP efficiencies in conducting programs under flexible agreements (which may well lead to earlier product availability than the conventional defense acquisition processes), the solicitation and negotiation phase was not significantly faster than the normal DARPA Broad Area Announcement process. This was due, in part, to the necessity of teaching potential government and industry participants about the TRP and its approaches and to sometimes difficult and lengthy negotiations conducted without the constraints of the FAR. It should be emphasized that both of these expenditures of time seemed to pay off in terms of enhanced program definition.

B. Summary Remarks From Panel Member Visits

The Panel members visited senior industry and Service representatives to obtain their views on dual use. They encountered a wide variety of viewpoints, illustrating both agreement and disagreement on different aspects of dual use. Comments of those interviewed are found in Annex C.

There was general agreement in these discussions that something new must be done to take advantage of commercial products and technologies and that the answer may well be dual use. Although the concept was considered unproved, all those interviewed felt that dual use could deliver military benefits by emplacing more "commercially-friendly" processes in the DoD. It was also agreed that what is now the TRP should become a joint program within OSD, and must be driven by user need. There is such a follow-on program planned, called the Dual Use Applications Program (DUAP). There was general consensus among those interviewed that the initiating Memorandum of Agreement should have been signed at a higher level.

Opinions diverged, however on the operational characteristics of the program (e.g., the wisdom of cost-sharing and non-procurement agreements) and whether dual use should ever intrude on "core" Service funding.

C. Conclusions

The conclusions of the DUR Project are summarized below:

1. The TRP has made significant progress in establishing a new way of doing business.

As a prototype for an element of a larger DoD initiative, TRP has moved the DoD toward achieving policies and precepts outlined in the 1995 Defense Science Board (DSB) Summer Study [9]. Such processes as innovative agreements and cost share are important characteristics to import into a DoD dual use initiative, although there will be differences due to the expanded scope of the new initiative. Cost share, for example, may not be necessary for all phases of dual use. An insertion opportunity may be negotiated with industry by simply having government pay for modifications to existing commercial products in order to ensure compatibility with other defense systems with which it must interface. This allows a commercial component to be bought directly without levying development costs on the producer. On the other hand, for co-development efforts, the offer of cost share by industry will provide an assertion that the proposed program is commercially viable. A fifty percent cost share is thought to be a good floor level for industry contribution.

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11 "Technology Reinvestment Project, Process, and Outcomes of the 1993 Competition," GAO Code NSIAD-905-99-705032 (June, 1995)

Even though it did not progress far enough to test the greater details required for successful insertion, TRP has demonstrated a different business process as a means of seizing opportunities. However, the TRP should not be sustained as a technology development program unless it becomes a part of a DoD dual use initiative that is broadened to address *all phases* of a product's development cycle — from research to insertion — as this report recommends.

2. Dual use can make major improvements in warfighting capabilities and affordability of military systems – *and it is faster!* Several compelling examples of existing and emerging Dual Use Products convinced the Panel that there is great opportunity for enhancing military capabilities through exploiting the commercial sector. Affordability improvements, as well as increased availability, are major benefits to be gained. Further, the introduction of commercial products, processes, and technologies naturally leads to more efficient equipment repair, replacement and upgrading when standard commercial technology is used, rather than one-of-a-kind military items.

It is clear that, while the DoD is an enthusiastic, if sometimes inefficient, buyer of commercial goods, there are important areas of DoD acquisition where commercial goods have not fully penetrated. For example, few commercially-based systems get into combat. Weapons and support systems that see the battlefield are generally still developed and built by the defense industry under the provisions of the FAR.

There are certainly exceptions to this rule. Often these exceptions take the form of a Non-Developmental Item (NDI). For example, 80% of the components of the ubiquitous High-Mobility Multi-Purpose Wheeled Vehicle (HMMWV) are commercial parts, enabling affordable and prompt maintenance support. Another example can be found in Raytheon's line of MILVAX computers. These computers are manufactured by Raytheon under license from the Digital Equipment Corporation (DEC) to meet military specifications for packaging, environmental constraints, etc. The military also benefits from the extensive line of VAX computer software available commercially. [8] DEC's popular VAX computers are also available on the international market and are used by the Dutch Navy for command and control applications. [10]

Still another NDI example is the KC-135. In the 1950s, Boeing developed a prototype four-jet swept-wing aircraft, the Dash-80, to address both the military and commercial markets. The military derivative of the Dash-80 is the KC-135, which replaced the Strategic Air Commands KC-97 propeller-driven aerial refueling tanker. The Dash-80 also spawned the Boeing 707 commercial airliner. "Boeing's willingness to invest in the Dash-80 ... followed from the prospect of both military and commercial sales." [8]

But, these are still the exceptions to the rule. Although few militarily-capable weapons systems will be found on the commercial shelf, components at lower tiers could often be introduced into these systems in place of military specification parts, saving large amounts of procurement and upgrade dollars and shortening procurement timelines without incurring unacceptable performance shortfalls.

Commercial technology is also being slighted, to the detriment of the DoD. [8] Although the DUR Project did not take the time to catalog them, there are a great many stories of defense R&D community neglect of commercial technologies in favor of those developed, or being developed, in-house. There are certainly substantial and growing dual use opportunities in many areas of electronics (e.g., communications, information systems, semiconductors, and power electronics), vehicles, and individual soldier equipment. The imposition of military specifications and standards on emerging technologies complicates any attempt to adopt or adapt commercial tech-

nologies for military use. This is changing in response to Secretary of Defense initiatives in acquisition system reform, but these changes are being manifested slowly.

Dual use technology development can be made more efficient and affordable through cost share by participating industries to help to defray developmental costs. Working with the commercial sector, through co-development efforts, instead of simply hoping for an applicable commercial product to emerge, ensures a better chance of getting something that the military can use. Examples of emerging TRP technology co-development products are presented in Annex D.

Overall, the greatest opportunities in exploiting dual use benefits lie in the proper approach to "make-or-buy" decisions. A discussion of strategies to be used in making these decisions is offered in Section IV, with some important thoughts on pertinent aspects of the product development process in Annex E. The value of these strategies and processes lie in how well they serve the operational user (the Warfighter), who must be able to drive decisions toward ensuring military benefit.

3. Commercial success is crucial to maximizing military benefits. A conclusion derived from Panel experience — and reinforced by the results of the TRP questionnaire [5] and case studies — is that the individual dual use programs rely heavily on the commercial market for their survival, regardless of how well they do in the military market. In general, without commercial success, military benefits cannot be realized from a dual use venture.

4. Dual use can create new programs and Dual Use Products that would not otherwise happen. TRP case studies [4] reinforced a belief that dual use can bring programs and products into the military that would not have been attempted by industry on its own. Lowering program and market risk by offering a potential (military) market, sharing cost, encouraging consortia, and adding government support of the credibility of the program are all key to bringing this about.

5. Dual use is applicable to all phases of the product development life-cycle. It was clear that the benefits of dual use should not be confined solely to the R&D phase, or to any other portion of the product development life-cycle. The judicious consideration of the "buy commercial" option in "make-or-buy" decisions is of crucial importance as will be discussed later.

6. Effective dual use demands commitment. The operational user, Service acquisition community, and industry (both commercial and defense) must support the concept of dual use if it is to be successfully used by the DoD. Too many traditions and values will be challenged by dual use for it to be proliferated casually. The implementation plan offered in Section V addresses this reality.

7. The dual use process is essentially opportunity-driven. Dual use also cannot be successful without the adoption by the DoD of a mindset to seek out "good deals" for the military and create relationships with industry that will produce usable technologies, products, and eventual insertion. The viability of these opportunities must be determined through scrutiny by a team of experts, including technologists, major systems program managers, legal and contracting officers, and operational users. These experts must also participate in product trade-offs necessary to make it viable for both military and commercial sectors. The training and education necessary to instill an appreciation for the techniques and attitudes that make dual use work should be provided to all of these participants.

8. Dual use training and education is essential. The Dual Use Approach and its tools are unique in many ways, and the attitudes demanded of both government and industry participants is

a revolutionary departure from the normal defense acquisition mindset. It is vital to *teach* the skills and values necessary for a successful dual use program.

9. Incorporation of dual use into the DoD requires a strong SECDEF mandate – BUT, it cannot be done simply by decree – an implementation arm is needed. Because dual use is of vital importance to all Military Services, it must eventually be incorporated into each of their normal acquisition system processes. But it is imperative to conduct dual use in a multi-Service context for the near future, with support and involvement at sufficiently high levels in OSD and the Military Departments and Services to break through the resistance of those who would maintain the status quo. An implementation strategy and its purposes are discussed in Section V. Now is an excellent time to begin a much broader, more aggressive dual use implementation initiative in the DoD, taking into account lessons learned from history in general, and the TRP in particular.

SECTION IV.
A DUAL USE STRATEGY

A. Three Pillars

Three pillars of dual use technology policy are identified in the February 1995 OSD report, *Dual Use Technology: A Defense Strategy for Affordable, Leading-Edge Technology* [7], and reproduced in Figure 4, below. These represent goals of acquisition reform affiliated with bringing Dual Use Products into the DoD. All three goals must be addressed through a carefully conceived and unified DoD-wide implementation plan.

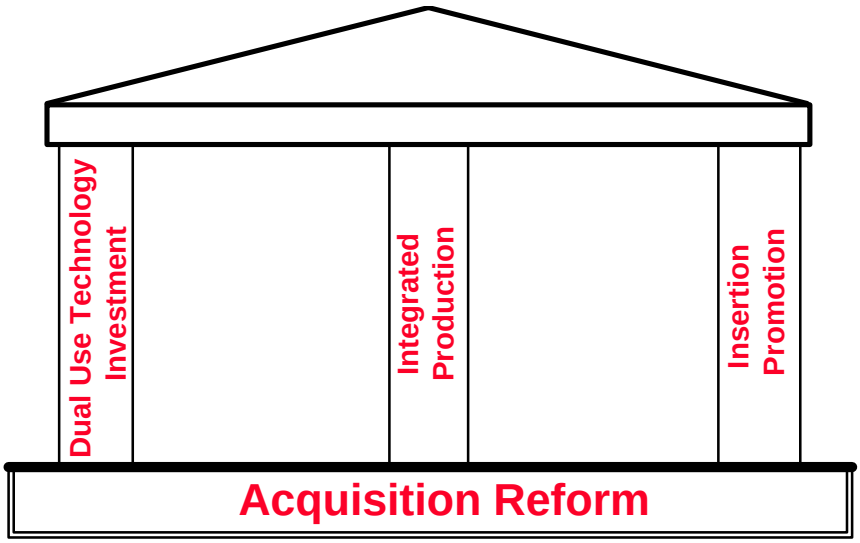

FIGURE 4. THREE PILLARS OF DUAL USE TECHNOLOGY

It is worth noting that, although the first pillar, Dual Use Technology Investment, has been illustrated with some degree of success by such programs as SEMATECH, Strategic Computing, and the TRP, the second and third pillars have yet to be designed and "built" in a convincing manner.

The second pillar, Integration of Commercial and Military R&D and Production, is occurring to some extent. The DUR Project has uncovered instances where companies have turned to commercial practices to develop (and, in some cases, to produce) systems for both commercial and defense markets. But even these industries are haunted by the suspicion that the military will not accept their products without the imposition of military specifications and standards.

Finally, the third pillar, Insertion of Products, Processes and Technologies — whether through a simple "buy commercial" decision or the result of a co-development effort between government and industry — is painfully hard. The implementation plan, described later, provides a way to involve the operational user and others who are part of the process of transitioning products into

military systems. As stated in reference [7], "... dual use investments [must] be selected based on their relative importance to the DoD."

B. The Dual Use Strategy Defined

The goals stated above, investing in dual use technologies and integrating and inserting Dual Use Products into the defense sector, are addressed through a three-step strategy formulated by the Panel.

1. **In a "make or buy" decision:**[12]
   a) **"make" should be the last resort, while**
   b) **"buy" should be the rule, when possible.**
2. **If no commercial product adequately addresses a military concept-based need, try to change the concept to accommodate commercial solutions.**

- Or -

3. **Introduce a third option, the "co-development of dual use technologies or products" through a joint effort with industry.**

Obviously, choices are seldom this clearly delineated, and areas that appear to be good investment opportunities should be pursued through technology development programs with industry. This strategy is illustrated in Figures 5 and 6.

In considering this strategy and its benefits, the Panel developed conceptual models of the market, the product development process, dual use relationships between commercial and military product cycles, and the various levels in notional work breakdown structures that apply to virtually any products or systems. These are discussed in Annex E.

C. Today's Dual Use Strategy: the "Make" or "Buy" Decision

Procurement options generally presented to today's acquisition official can be expressed as "make" or "buy." Figure 5 graphically depicts these options.

[12] "Make" is defined as the acquisition of defense-unique products designed and produced by defense laboratories and industries, while "buy" implies an acquisition of commercial products (COTS equipment or NDI).

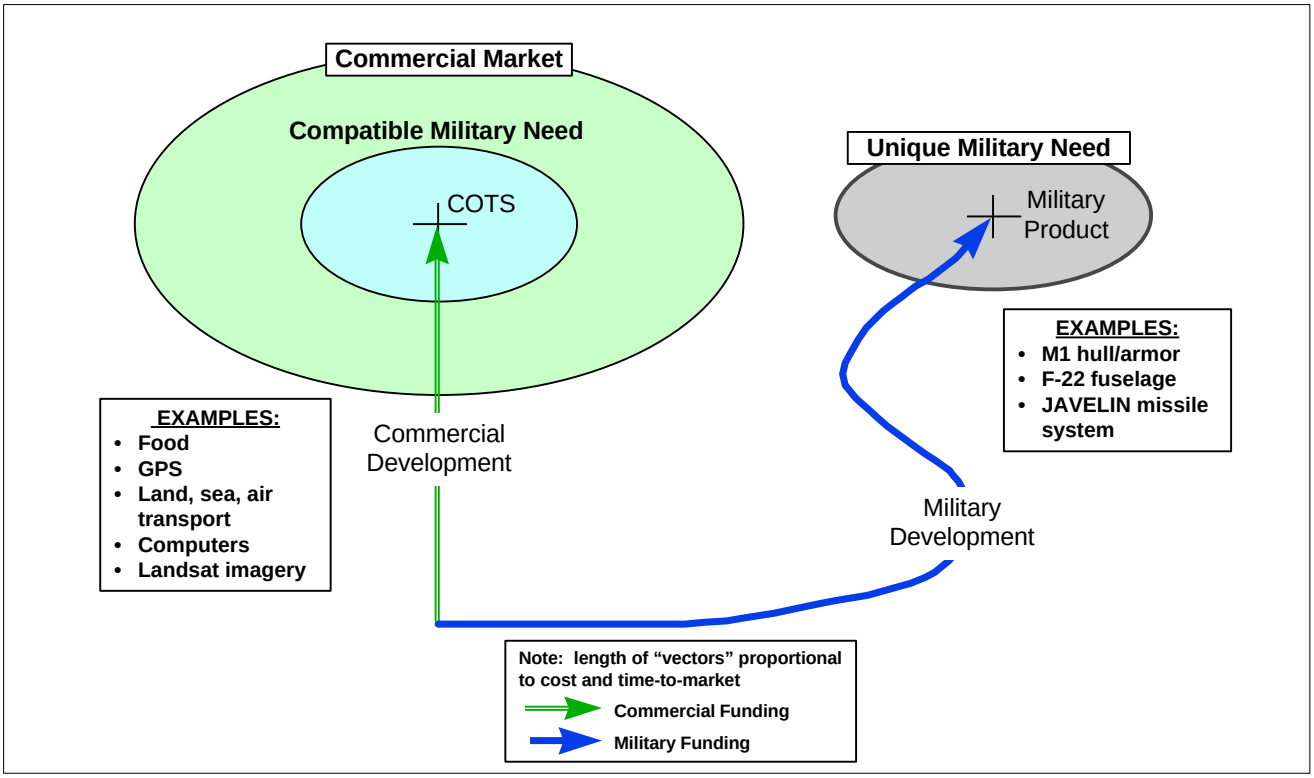

FIGURE 5. TODAY'S DUAL USE STRATEGY: "MAKE OR BUY"

For many military-unique systems, such as weapons and combat platforms, the area of military need exists outside of the commercial market and the "make" decision may be warranted. This decision, shown on the right side of Figure 5, is to conduct the development of the item in question through conventional DoD acquisition system procedures, guided by the FAR and involving competitive procedures, which result in prime- and sub-contractors funded totally by the DoD. Although there are a number of enacted or proposed acquisition reforms that will render the "make" option more efficient, the Panel believes that it will remain a relatively expensive and time-consuming option. On the other hand, a "buy" decision (shown on the left-hand side of the chart) is defined as simply purchasing COTS equipment, or an NDI. Symbolically, time-to-market and cost are represented by the length of the "funding vectors" in Figure 5 that lead to the products. The funding and time required to produce a military-unique product is generally much longer than that for a commercial product. Of greater consequence are the contribution of development dollars and the continued involvement of the commercial sector in evolving and supporting products for the latter case.

An increase of COTS equipment "buys" can be expected as a result of acquisition reform, which has been emphasized by both the Administration and the Congress. The Panel feels that acquisition reform is of crucial importance, but most of its initiatives are beyond the scope of this study. Therefore, such reform issues as limiting competition, eliminating fee limitations, changes to the Truth-In-Negotiation-Act (TINA), changes in cost accounting requirements, and so on, are addressed in this briefing only in their dual use context.

Three points should be stressed. First, the "make" choice is often dictated by lack of commercial interest in the end product sought by the military. As military procurement represents a progressively smaller percentage of the total market, it will become accordingly more difficult to interest commercial industry to respond to military needs. This point is clearly made in Annex E. 1. Second, the DoD should work hard to avoid choosing the "make" option, and third, more and

more procurements will involve mixing "make" and "buy" elements. This mixing process allows commercial efficiencies and Dual Use Products to be integrated with military-unique components to form the system. This process is described in some detail in Annex E. 4. Since the integrator is generally the prime contractor, defense industry must become a major focus of the DoD dual use initiative.

D. A Dual Use Strategy: Alternatives to "Make"

Figure 6 schematically describes two strategies directed toward avoiding the "make" option, when "buy" is not a straightforward solution. Although quite different tacks are taken, the most successful approach will probably be a combination of both.

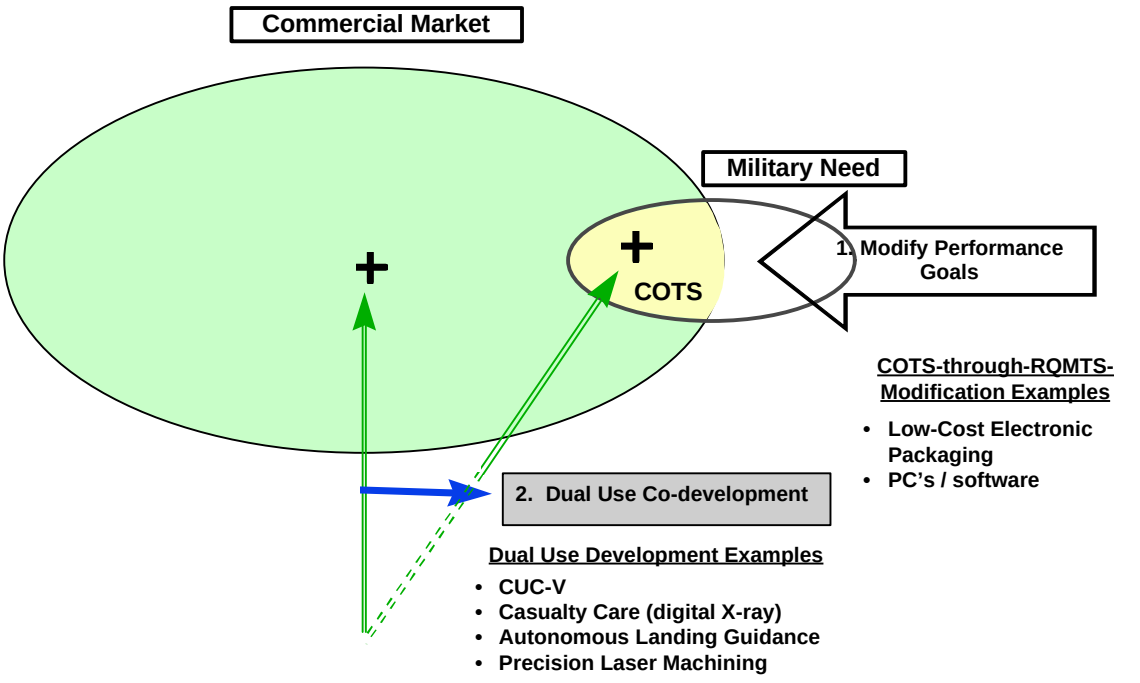

FIGURE 6. A DUAL USE STRATEGY: ALTERNATIVES TO "MAKE"

1. Modify Performance Goals. This strategy can be viewed as relaxing or changing requirements (and thus military specifications) in order to allow a decision to buy a Dual Use Product. [13] Opportunities to take advantage of commercial goods through a change in military requirements may be legion, but care must be taken to ensure that the resulting product will really satisfy military needs, since often quite different design tradeoffs must be made for the battlefield than for commercial use.

So, this is a decision replete with complexities. For example, even though an entire military system design may not be responsive to a COTS buy, many of its components may be, with an ac-

[13] In some cases, this may lead to changes in defined needs, or in military doctrine itself.

ceptable relaxation of military specifications. These considerations demand a "brokering" process involving a search for possible commercial substitutions. But any brokering must center on the needs of the warfighter, and it must be accomplished through a multi-disciplinary team. The operational user must be an integral part of this team, regardless of how technologically arcane its issues might be. This process is pictured conceptually in the right-hand side of Figure 6 by moving the "Military Need" area closer to its commercial counterpart.

2. "Co-Development" of a Dual Use Product to Meet Requirements. There are many important cases where no available commercial product or process will serve a military need, even after making acceptable changes to requirements. The Panel believes that a large subset of these cases will respond to efforts, jointly funded, planned, and conducted by the DoD and industry, to co-develop technologies, processes and products that will respond to the need of the military sectors and, simultaneously, appeal to the commercial marketplace.

The goal of a "co-development" effort is to shift the target of commercial development from a product designed only to address the commercial market to one which also addresses military need. This is represented conceptually in the left-hand side of Figure 6 by the displacement of the development path from the Commercial Market centroid to a region that embraces military need as well. The resulting Dual Use Product satisfies both communities, and the funding to develop it is shared by government and industry. Examples of such "co-developed" Dual Use Products are offered in the TRP case studies report. [4] In some cases, COTS may not offer a reasonable common ground for the military, and a Non-Developmental Item may be required, which would lie just outside of the "Commercial Need" area.

E. Summary

The preferred choice for acquisition is clearly the "buy" decision, wherever possible. If neither COTS nor NDI products meet the military's needs, modification of performance goals or co-development alternatives must be considered — along with the "make" option — and the relative benefits of all three weighed before a decision is reached on how to proceed.

The remainder of this report will propose an implementation plan designed to enhance the adoption of this strategy.

SECTION V.
IMPLEMENTATION PLAN

A. The Plan

All of the opportunities to benefit the military through exploitation of the commercial sector and the evidence of feasibility provided by the TRP and other programs will mean little if the Dual Use Approach is not broadened in application and infused throughout the Services. The implementation effort must respond to two challenges. The first is to disseminate knowledge in organizing and conducting dual use technology development programs. Much of this knowledge, gathered during the TRP and other dual use technology development programs, is already resident within DARPA, but new insights are needed to determine the best ways to perform these functions inside the Military Services. The second challenge is to learn how to effectively conduct dual use technology and product insertions into military systems. Less experience is evident in this very important arena and much innovation will be needed. It is important to note that this second challenge must involve the weapons systems prime contractors.

There are at least five facets to the proposed plan to meet these challenges: Policy, Education, Oversight, Institutionalization, and funding. These five aspects are discussed in following paragraphs.

Implementation may be a very difficult mission due to biases in the DoD toward the status quo. Failure to fully implement dual use in the DoD will represent a setback that may take years to redress. The DoD must treat this implementation as a major effort or it will likely be unsuccessful.

It is vital that the DoD implement dual use decisively, but the implementation effort itself is transitional and should be terminated within five years. Five important principles guided the formulation of this plan:

1. Dual use can make major improvements in warfighting capabilities and affordability of military systems. This was the Panel's principal conclusion. It is repeated here to reinforce the importance of a strong implementation plan. The body of this report provides evidence of the crucial benefits to be gained through exploiting the commercial sector.

2. The changes required to conduct dual use programs in the DoD are profound and, in many cases, counter-cultural. New skills and attitudes must be cultivated in the DoD in order to effectively perform functions required by the Dual Use Approach. These functions include searching the commercial sector for Dual Use Products suitable for the military, trading-off desired military characteristics for commercial affordability and product support, negotiating *flexible agreements* without burdensome regulations, and conducting the resulting program or insertion as a partner with industry. Performing these functions under the constraints of the normal defense acquisition system is likely to be inefficient and frustrating.

3. The most effective way to embed dual use in the DoD is to implement it through a strong policy statement coupled with a joint Service implementation arm. Decisive implementation demands active support from the highest echelons of DoD, coupled with

an implementation arm, which the Panel has called the Joint Dual use Implementation Office (JDIO). A Secretary of Defense policy directive is needed to emphasize the importance of dual use to the DoD and to establish the components of this implementation plan.

The directive should appoint a Senior Dual use Board (SDB) to oversee the implementation and to set policies and review proposed targets for dual use programs. Under this plan, the SDB will be co-chaired by the Undersecretary of Defense for Acquisition and Technology [USD(A&T)] and the Vice-Chairman of the Joint Chiefs of Staff. The SDB will consist of the Service Vice Chiefs of Staffs to ensure that operational requirements are addressed, and other members deemed appropriate by the USD(A&T) to address acquisition policy.

The JDIO will teach participants in government and industry to use the basic "dual use tools," through formal training and by demonstrating the Dual Use Approach and the military benefits of that approach. The latter will be accomplished by encouraging and guiding the formation of Service "Tiger Exploitation Teams"[14] to find, propose, and conduct dual use efforts. In this way, dual use will be performed under the guidance of the best dual use experts in the DoD, while "the action and the learning" will occur outside of both the JDIO and the normal acquisition process. The JDIO will provide funding for seeking out prospective Dual Use Approaches that are specifically tailored to leverage the commercial sector. The JDIO will also report progress and make recommendations to the SDB in order to improve the effectiveness of dual use programs and policies. New lessons should be passed across to the Services and up to the SDB. These lessons should be incorporated into policy and regulation documents at all levels in order to educate and to empower and motivate DoD acquisition officials to employ dual use throughout the spectrum of defense business.

The purpose of funding this program is to enable and motivate the Military Services and Agencies to adopt dual use as a primary basis for their day-to-day business operations. As dual use becomes "normalized" throughout the DoD and is embedded in all phases of the acquisition process, this temporary funding will "sunset" (in 3-5 years) right along with the organization — the JDIO. During this transition period, the funding should be provided as a separate line and not derived by taxation of ongoing, established DoD programs.

From the study of TRP records and statistics, the Research Team found evidence that this implementation approach can work. In 1992 the National Aeronautics and Space Administration (NASA) sent personnel to the TRP to learn how DARPA was using Cooperative Agreements. During the next two years, the encouragement and feedback of information by the principal NASA representative on the TRP staff, along with experience gained by NASA in managing the eleven TRP programs allocated to them, resulted in a significant increase in the number of these flexible agreements employed in NASA programs, as shown in Figure 7.

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[14] Tiger Exploitation Teams, suggested by the 1995 Defense Science Board Summer Study, are essentially Integrated Product Teams (IPTs) that could be led by a PROJECT OFFICE, a User, DARPA, or the Service Laboratories.

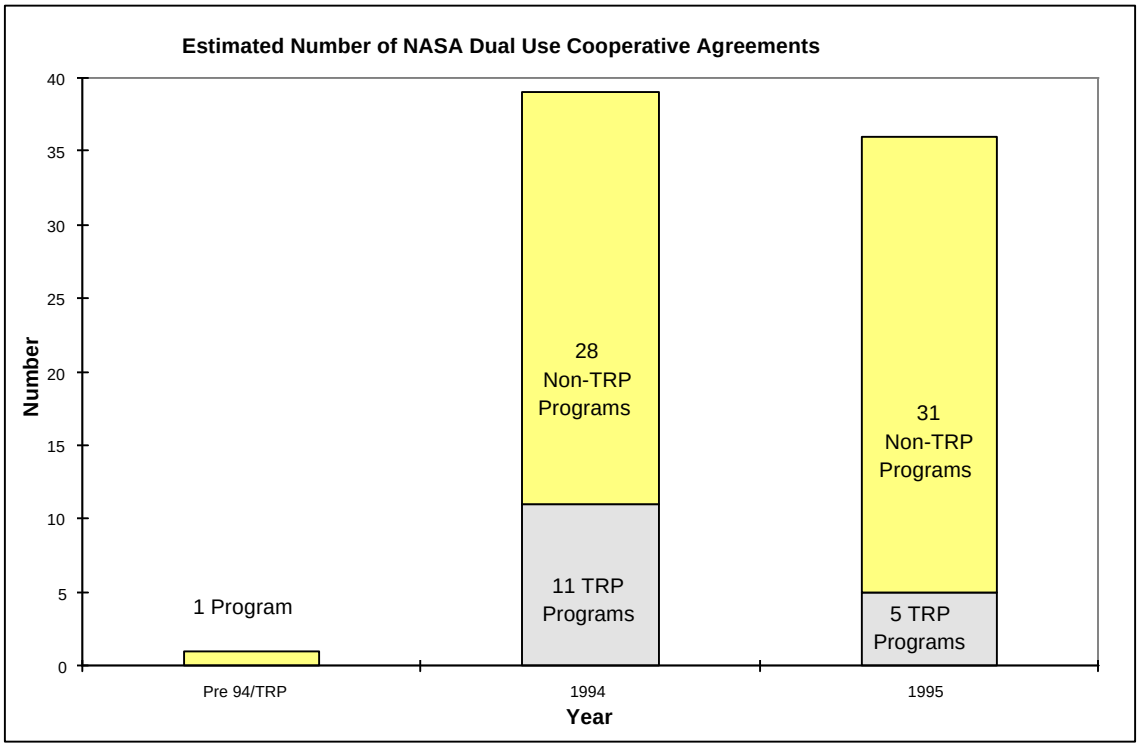

FIGURE 7. COOPERATIVE AGREEMENTS IN NASA

4. The implementation effort should ensure the incorporation of dual use practices into all phases of the product development cycle. The implementation effort must represent a critical mass in order to make a difference. It should house all aspects of dual use "under one roof" (even though some of these aspects will be small demonstration efforts). For example, activities currently underway in the OSD would be natural and valuable components of this more broad-based dual use implementation scheme. The JDIO and the Tiger Exploitation Teams will operate across all stages of the product development cycle, from research to insertion, to bring Dual Use Products at every stage of development into the DoD. In this way, tradeoffs can be made among acquisition strategies, for example, between co-development and direct insertion of a product. Further, the approach will be consistent across all phases.

5. It is the judgment of the Panel that, with education and training and a change of culture, dual use should evolve into the primary mode of development and procurement in the DoD.

B. JDIO Responsibilities

The major goal of the JDIO is ***to demonstrate and embed dual use into the Military Services.*** Central to the JDIO's approach is involvement of people from the Services and OSD in both formal courses and dual use programs. This approach is designed to convince a broad spectrum of the DoD acquisition and user community of the value of dual use and to teach them how to gain its benefits. This objective is reflected in the JDIO responsibilities discussed below.

1. Sponsor and oversee dual use development, application, and insertion programs. The mission of the JDIO should not be simply to initiate new programs that can be justified as

dual use. The first filter for accepting a proposed program or effort must be, as always, military need. All dual use initiatives must hold this criterion paramount. In fact, critics will continue to concentrate the most intense scrutiny on this issue. The JDIO should target both on-going Service programs that could profit from a dual use approach (either in lieu of, or in parallel to, the existing effort), and new starts. The most important outcome of this transitional implementation effort must be to "normalize" the employment of dual use throughout the DoD — to convince and teach its benefits and to show how to arrive at those benefits by involving people in on-the-job-training in Dual Use Approaches.

The process of conducting the JDIO programs is discussed in Section C (below). It will be noted that nearly all of the action is to be conducted outside of the JDIO, for a number of reasons. It is imperative that the Services (and, in some cases, OSD) gain the experience of choosing and executing dual use programs. On a more practical level, the JDIO will have neither the personnel nor the resources to conduct a stand-alone operation. Further, participation may encourage the Services to initiate their own programs when dual use opportunities exceed the JDIO budget. So, the predominant roles of the JDIO are distinguished by words such as: "advocate, facilitate, sponsor, advise, organize, broker, oversee, train, and coordinate."

The innovation required so far to develop the TRP's approaches and processes has been commendable, but considerable *further* innovation must occur if the DoD implementation phase is to be successful. As better ways of doing things are developed by the participants, these ways must be adopted by the entire DoD community, and warranted changes to policy and regulations must be recommended to the SDB.

Another key to successful demonstrations is the accessibility of expertise in the Dual Use Approach. This expertise, initially to be concentrated within the JDIO and then propagated to the Services, is also needed to assess the effectiveness of the approach and the policies that support them. Personnel must also be dedicated to performing the difficult "missionary" work required to embed dual use throughout the DoD. Scarce resources will be better spent, in many cases, by addressing multi-Service goals and conducting programs via a lead Service, or by utilizing joint teams.

2. Develop & implement Education and Training programs. The JDIO must formulate and implement formal courses to provide dual use training and education to Service and OSD personnel at all levels for application to all phases of the acquisition system. DARPA has made a start through the training that the TRP has provided to participating agencies, but much additional work remains. Courses must include a history of dual use in the DoD, how well it has worked, and an identification of some of the factors that affected it. Solid training in dual use background skills should follow, to include an understanding of the DoD policies and processes used in soliciting, evaluating and conducting programs. Also to be covered are parameters of "make-or-buy" decisions, pitfalls (especially where the FAR must be used), and of course, special subjects such as intellectual property rights and foreign involvement. The necessity to considerably broaden the negotiation process is a major distinction of dual use, and it cannot be done without changing attitudes and procedures operational in the DoD acquisition system today. An understanding of the search process for Dual Use Products is critical to success, and must be covered. The operational user, who plays a significant role, must be apprised of some of the trade-offs that must often be made in order to take advantage of dual use. In some cases, it will be sufficient to tap the knowledge and experience that resides in DARPA, but it will also be necessary to introduce new insights from both inside and outside of the government. The Defense Systems Management College (DSMC, Ft. Belvoir) would be an excellent place to begin training

upcoming program managers in the benefits and techniques of dual use i.e., a strong curriculum package in dual use could be added to the current training regimen at DSMC.

3. Report and make recommendations on progress. The reporting function of the JDIO involves informing the SDB and the USD(A&T) of progress, problems, and new techniques. It should also make recommendations on policies and regulations that should be initiated or changed.

C. Some Ideas on Conducting Programs

The JDIO's programmatic approach — moving dual use into the main-stream, concentrating necessary resources, and innovating better processes through sponsoring dual use programs — were discussed above. The following discussion presents a suggested process for choosing and conducting these dual use programs.

Each program sponsored by the JDIO will generally be conducted in four phases: Search, Program Definition, Solicitation, and Program Conduct. At any particular time, there may be several ongoing programs under JDIO sponsorship, and they may all be at different phases. Each program will be developed and conducted by a Tiger Exploitation Team (or "Tiger Team") under the leadership of one or more of the Services, or of an organization within the OSD. A program may be a collection of related projects (e.g., a Technology Focus Area), or a single project. Programs may be research, technology development, or product insertion efforts. They also may be new starts or "a better way" to accomplish already-planned objectives. The approach is illustrated in Figure 8 and is discussed, phase-by-phase, below.

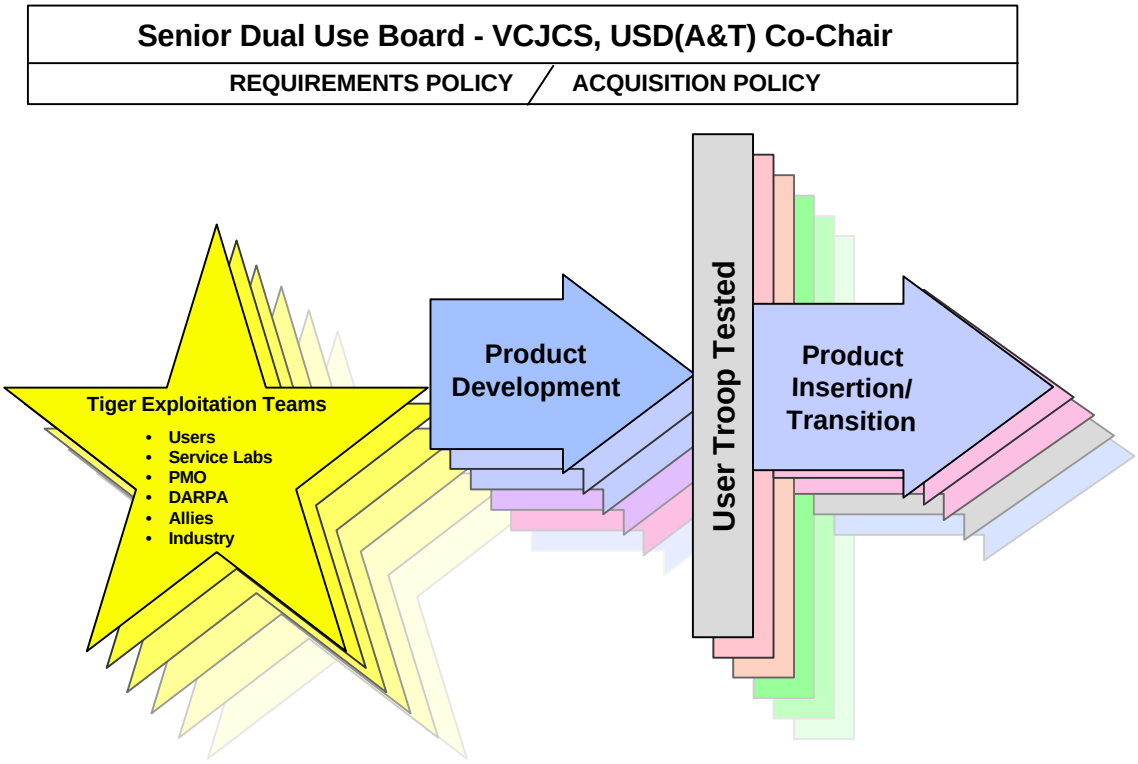

FIGURE 8. SOME IDEAS ON CONDUCTING PROGRAMS

1. Search Phase. The objective is to collect information on commercial technologies, processes and products, to connect them with user needs, and to form strategies to exploit them. The JDIO role in this phase is to encourage the formation of Tiger Teams in various areas, to coordinate

among Tiger Teams, help to guide the searches, and collect, integrate, and distribute information derived from each study. Tiger Teams may be formed around a user need (e.g., Small Unit Operations ACTD), a technology area (e.g., Casualty Care), or a particular product (e.g., an M1A2 Tank auxiliary power unit). In each case, there must be a clearly stated user need and a strategy to satisfy it through leveraging the commercial sector. Tiger Teams may be composed of representatives of the user, Service Laboratories, Service or DARPA Program Managers, and may have defense representatives of allied countries, if there are international opportunities or needs to be addressed. It may be well to include industry associations or consultants at this stage.

2. Program Definition Phase. The principal task to be undertaken during this phase is to develop the rationale for pursuing each proposed program or program area. This rationale will be submitted by each Tiger Team to the JDIO and will include a user statement, initial development and insertion strategies, and a market analysis. Details that are necessary to support the program area may include affordability constraints and cradle-to-grave support requirements. Laboratory and troop testing necessary to establish military utility for the program deliverables should be proposed, as well as troop units willing to serve as Troop Test Beds. At the conclusion of this phase, a judgment will be made by the JDIO, and reviewed by the SDB, on the distribution of JDIO funds among programs proposed by the Tiger Teams.

3. Solicitation Phase. By this time the dual use programs or program areas have been chosen. Funding is allocated for a competitive or sole source selection (it may be a combined solicitation of more than one program area) and the solicitation is written and published. The solicitation should include a clear statement of user need and an idea of any special troop or laboratory testing contemplated for the Dual Use Product. Evaluation teams are formed as needed, through the Tiger Teams, and final selections are made within each program area. At this time, final adjustments on the funding distribution among programs is to be made by the JDIO, contracting and management responsibilities finalized, and negotiations begun on program agreements.

4. Conduct of Program. Funding allocations are made by the JDIO, the winning companies become part of the Tiger Exploitation Teams, and the program begins. Troop Test Beds are formed as appropriate. As the program proceeds, the Tiger Team maintains a close relationship with the developer to ensure that military utility is maintained and that milestones are met. Program and transition strategies, test plans, and other program aspects are finalized through the Tiger Team. During this phase, the JDIO advises, coordinates cross-program opportunities, and reports progress to the SDB.

D. Measures of Success

Where will we be five years from today? Figure 9 schematically represents DoD's recent dual use history and future options. There is an opportunity to move ahead and, within five years, "normalize" the adoption of commercial output into the Military Services and "sunset" the formal JDIO implementation program. Alternatively, DoD may opt to return to "business as usual," forfeiting the gains made during the last four years through the TRP.

Success in five years will be characterized by how well the following tasks are accomplished through the implementation effort:

1. **Dual use is standard operating procedure throughout the DoD, Services, and Agencies.**
2. **The DoD Services and Agencies understand and can leverage the commercial market.**
3. **Linkage between the operational and acquisition communities is sufficiently strong and effective to make the decisions and trade-offs necessary to adopt and adapt commercial products.**
4. **COTS and NDI options and inventories are dramatically increased, with attendant savings; Service dual use skills and support are manifest.**

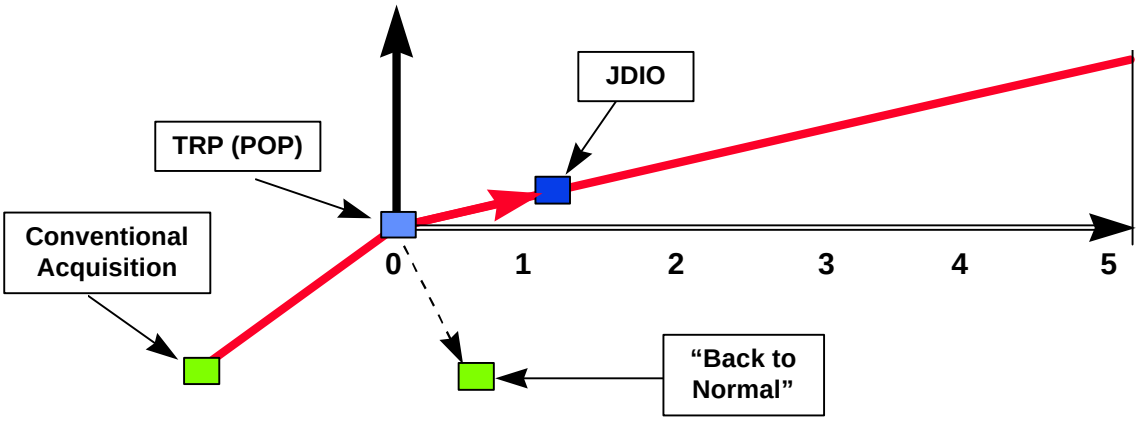

FIGURE 9. CHOICES FOR THE DOD

ANNEX A.

1 SEPTEMBER 1995

MILITARY AND INDUSTRY PANEL TERMS OF REFERENCE

Membership

GEN Al Gray (Ret, USMC), Chairman: From 1987 - 1991, General Gray served as a member of the Joint Chiefs of Staff and was the 29th Commandant of the Marine Corps.

Dr. Ed David: Dr. David is President of EED, Inc. During his career, Dr. David served as Science Advisor to the President of the United States and Director of the White House office of Science and Technology. He also served as President of Exxon Research and Engineering Company, and Executive Director of Bell Telephone Laboratories.

GEN Glenn Otis (Ret, USA): During his last five years of military service, General Otis commanded all the Army forces in Europe. Following his retirement in 1995, General Otis has been a Senior Fellow at the Institute of Land Warfare of the Association of the U. S. Army.

Mr. Hal Edmondson: Mr. Edmondson was Vice President of Hewlett-Packard, Inc. He retired in 1996 to consult for industry and government.

Mr. Howard Schue: Mr. Schue is Partner and Executive Vice President of Technology Strategies and Alliances Corporation, and is Director of the Board of the Potomac Institute for Policy Studies. He was Vice President of C^3I Systems in AT&T Technologies Federal Systems Division.

RADM Walter Cantrell (Ret, USN): RADM Cantrell is currently Executive Director of Technology and Systems for Global Associates, Ltd. His last military tour was Commander of Space and Naval Warfare Systems Command, from which he retired in 1995.

LTG James Clapper (Ret, USAF): General Clapper retired from military service in 1995. His last assignment was Director, Defense Intelligence Agency. He currently serves as Vice President for Special Projects of the Potomac Institute for Policy Studies.

Dr. James Richardson, Panel Coordinator: Currently a Senior Fellow at the Potomac Institute for Policy Studies, Dr. Richardson was Director of the Land Systems Office at DARPA.

Background

The Technology Reinvestment Project (TRP) began under the leadership of the Defense Advanced Research Projects Agency (DARPA) in 1992. The purpose of the TRP is to introduce new and more affordable technologies into the military by sponsoring the development of dual use products and processes. The strategies employed in accomplishing this end is to exploit superior commercial advancements and efficiencies and to encourage the commercialization of selected military technologies in order to reduce costs and improve performance of military systems.

To date, the TRP has held three solicitations. By the latter part of this year, it will manage well over one hundred technology development programs. The DoD plans to discontinue the TRP after FY96, in favor of a new dual use program. With this in mind, the Dual Use Research

(DUR) Project[15] has been initiated to investigate alternative ways to conduct programs in dual use technology development. The objectives of the DUR Project are 1) to investigate the military efficacy of dual use technology development, 2) to specify conditions under which dual use technology development is an effective method for improving the affordability and performance of DoD technology and 3) to suggest how a dual use approach should be implemented in the DoD. Specific deliverables are a survey paper on dual use, lessons learned from the TRP, and different options for conducting military dual use R&D. A follow-on effort is planned to brief the conclusions of the DUR Project to industry and the Military Services.

Objectives of the MIP

The Military and Industry Panel (referred to as the MIP, or Panel), will serve to focus the Dual Use Research Project and to draw overarching conclusions on TRP lessons learned, the military value of dual use, and ways to efficiently and effectively conduct a dual use program in the DoD. The Panel may recommend changes to these terms of reference, propose additional analyses, or seek alternative sources of information to augment their findings and recommendations. Specific terms of reference are:

1. Review data and analysis presented by DUR Project Research Team,

2. Provide guidance on conduct of research effort,

3. Formulate lessons learned from the Technology Reinvestment Project,

4. Provide conclusions on:

    a) the value of dual use technology development for the DoD,

    b) conditions under which dual use can be an effective method for improving the affordability and performance of DoD technology,

    c) approaches for implementing the dual use program process throughout the DoD, to include the following aspects:

        1) overall dual use strategies and goals;

        2) dual use program management and administration;

        3) military relevance;

        4) commercial motivation for dual-use investments;

        5) involvement of military Services in all phases of the TRP;

        6) involvement of industrial community in dual use programs;

        7) criteria to be used in choosing technology areas and programs; and

        8) product transition to the military and commercial worlds.

4. Discuss dual use problems and opportunities with highly placed officials of the OSD and Military Departments and Services, in order to understand how dual use can best be integrated into the DoD at large.

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[15] See "Dual Use Analysis Project Plan", dated 31 August 1995.

5. Deliver final report

6. Brief conclusions to Military Departments and Services and industry during follow-on phase

Operation of the Panel

The Potomac Institute for Policy Studies (PIPS) will establish and support the MIP. The Panel will be composed of experts in military and industry matters relevant to dual use. At least four Panel meetings will be held during the study to brief and consolidate the views of the Panel. Individual tasks will be assigned for the intervals between meetings.

Two sub-panels may be formed at the discretion of the Chair, one to focus on military aspects of dual use, the other to consider commercial potential and benefits. Chairs for each sub-panel will be nominated and selected by Panel members from among themselves. Based upon a consensus of Panel members, the Panel may choose to conduct its meetings and reviews as a whole or divide into its sub-panels. In all instances, the full Panel will be apprised of the findings and conclusions of its sub-panels.

Anticipated Level of Effort and Schedule

The Military and Industry Panel deliberations and reporting will extend over a one year period (1 October 1995 to 1 October 1996), with extensions if needed. The average time commitment for each member of the MIP is 150 to 200 hours. Key dates planned for initial panel meetings and events are listed below. All dates are subject to change.

September 1995

- 1st week: Begin project planning

October 1995

- 13 Oct. - 1st MIP Meeting (1 day):
  - I. Attend Dual Use Review (breakfast & tour of exhibits)
  - 2. Management & administrative matters
- 24, 25 Oct. - 2nd MIP Meeting (2 days):
  1. Introduction to dual use & the Technology Reinvestment Project (TRP)
  2. Briefing on DUR Project & Panel terms of reference
  3. Status of DUR
  4. Panel directions to research Team

November 1995

- 20, 21 Nov. - 3rd MIP Meeting (2 days):
  1. DUR Project update
  2. Panel agreement on case study selections
  3. Panel strategy session

December 1995

- 11 Dec. - 4th MIP Meeting (1 day):
  1. DUR Project update (TRP Statistics, Case Studies)
  2. Briefing and discussions on acquisition reform
  3. Briefings and discussions on the Commerce Department's Advanced Technology and Partnership for a New Generation Vehicle programs.

January 1996

- 17, 18 Jan. - 5th MIP Meeting (2 days):
  1. Update on government and DUR Project progress
  2. Submission of dual use survey Paper
  3. Submission of TRP statistics

4. Submission of case studies and analysis
5. Submission of completed questionnaire analysis
6. Panel Members' report on discussions with industry and military
7. Submission of proposed final report format
8. Begin work on final report
9. Discussion of future plans

February 1996

• 6, 7 Feb. - 6th MIP Meeting (2 days):

1. Report on completed case studies
2. Complete military & Industry Interviews
3. Resolve overarching questions concerning dual use implementation in DoD
4. Complete low cost electronics packaging case study
5. Complete next iteration of final report

March, April 1996

• 4, 5 Mar. - 7th MIP Meeting (2 days):

1. Complete interim report; provide consultative summary briefings to selected DoD civilian and military and industry leaders, as well as selected Congressional officials, as requested by them.

May 1996

• Complete final report

June - September 1996

• Conduct follow-on activities as requested

ANNEX B.
REFERENCES, BRIEFINGS, REPORTS AND PUBLICATIONS

1. References.

[1] James Richardson, (19 October 1995), *Dual Use Research Project Plan*, Potomac Institute for Policy Studies

[2] *The Technology Reinvestment Project — Dual Use Innovation for a Stronger Defense* (1993, 1994 Projects)

[3] Richard White, et al (17 Jan. 1996), *A Survey of Dual Use Issues*, Institute for Defense Analyses

[4] Adrian C. Smith, Jr., et al (6 Mar. 1996), *TRP Case Studies*, Potomac Institute for Policy Studies

[5] Shelli Roberts-Jurado, et al (6 Mar. 1996), *TRP questionnaires*, Potomac Institute for Policy Studies

[6] Diane Larriva, et al (6 Mar. 1996), *TRP statistics*, Potomac Institute for Policy Studies

[7] Van Atta, Richard, et al, (February 1995), *Dual Use Technology: A Defense Strategy for Affordable, Leading-Edge Technology*, OSD

[8] Alic, John A. et al, *Beyond Spin-Off*, HBS Press, 1992

[9] GEN Vessey, et al, *Revolution in Business Affairs*, (part of the 1995 Defense Science Board Summer Study, *Technology Investment for 21st Century Military Superiority*)

[10] Joris Janssenhok, *Jane's Defense Weekly*, 14 March 1992

[11] *Report of the Defense Science Board on Use of Commercial Components in Military Equipment, June, 1989*, Defense Science Board, Office of the Under Secretary of Defense (A&T)

2. Briefings to the Military and Industry Panel.

During the period, 13 October 1995 to 4 March 1996, several briefings outside the Research Team and the TRP, were taken by the Panel. These are listed in the order received.

1. Proprietary Rights, "Other Transactions": Rick Dunn, General Counsel, DARPA and Mike Nash, IDA
2. TRP History, Comments on Government Activities: John Jennings
3. Historical Examples of Dual Use Opportunities: Carolyn Ziemke, IDA
4. OSD Dual Use Efforts: Dick Van Atta, OSD

5. Casualty Care: Dr. Don Jenkins, DARPA Program Manager
6. TCIMS: COL John Silva, DARPA Program Manager
7. Pertinent Acquisition Reform Topics: Bill Mounts, Director, Commercial and Foreign Systems, OSD Office of Acquisition Reform
8. Briefing on ATP Organization, Approach: Brian Belanger, Deputy Dir., ATP, DOC
9. Partnership for a New Generation Vehicle (PNGV) Program (DOC): Rob Chapman, Dir., PNGV, Department Of Commerce

ANNEX C.
REMARKS FROM PANEL MEMBER VISITS

The Military and Industry Panel interviewed several leaders in industry and the government. The following are comments (paraphrased) from these conversations:

- DoD must make better use of commercial technology.
- Dual use must be driven by user need.
- Areas where government should invest in "exclusive" (e.g., military-unique) projects should be rare and carefully selected.
- Dual use as a program is not yet proven — but it does justify an extensive trial to determine feasibility.
- Spin-On is more credible than Spin-Off.
- The move to change TRP into a dual use technology in OSD is wise — may also reduce political controversy.
- Joint endeavors can pay off — the technical plan must be joint.
- DARPA/Services dual use program Memorandum of Agreement should be signed at a sufficiently high level.
- Possible mode of operation is for TRP to join into promising developments by industry — but industry should be both the driving force and a funding source.
- Rules to be followed should be commercial — not government.
- Administrative constraints should be addressed — "Other Transactions" is very important to dual use.
- Concern was expressed about Services' ability to adopt DARPA contractual vehicles, because of perception that these vehicles are not competitive and may prompt contractor protests.
- Strict "matching funds" requirement is a non-starter.
- Cost sharing must be a mandatory feature.
- If shared R&D costs can produce technology or products that the military needs at a lower cost, dual use has merit — if it takes funds from the DoD core programs, then it does not.
- Dual "producing" is harder and is not likely to be as successful as dual use development.
- USAF reaction is generally supportive of dual use concept, but there is concern over:
  - — spending AF money in areas where the commercial world is going to invest anyway, and
  - — the possibility of programs turning out not to be truly dual use (they could lose Service identity and funding).

- TRP is a good concept, but may not have advantages over established process — may be too new to be judged.
- USMC very supportive; prepared to assist in Test Bed/ACTD efforts.

ANNEX D.
EXAMPLES OF TRP PROJECTED SUCCESSES

A few examples of dual use objectives drawn principally from the TRP case studies [4] are detailed in this annex:

1. UNCOOLED IR. The US military has "owned the night" because of generations of cryogenically-cooled IR sensors. These sensors were a major reason for our ground victory in Desert Storm. Unfortunately, the high cost of cooled sensors has precluded wide distribution to combat troops for manportable applications. Although the performance of uncooled infrared sensors is below that of the cooled sensors, they are superior (in nearly all circumstances) to light intensification equipment that is today's low-cost alternative. The high cost of current cryogenically-cooled sensors ($30,000 to $40,000 per unit) has severely limited the thermal imaging market size. With the advent of uncooled IR sensors, there is an opportunity to overcome this cost barrier by reducing costs to between $1,000 and $10,000. Uncooled technology also offers improved reliability, "instant" operation (no "cool-down" time required), with no audible noise. Further, it may be possible to increase sensitivity from 0.1 degree at F1 aperture (appropriate for manportable systems) to the same sensitivity at F2 aperture (appropriate for missile sensors). But uncooled systems are still too expensive and, while they require more development for both performance and affordability, IR producers plan to reduce or eliminate R&D expenditures if they cannot find a larger market than the shrinking DoD budget will allow. The military procures about 10,000 units per year, but the potential civilian market is around 100,000 units per year. The TRP is leveraging commercial investments to address this market through three uncooled IR approaches. TRP goals are better-performing IR systems available to the military at less than one-tenth the cost. These TRP activities are attempts to embed IR into missile terminal guidance systems, 21st Century Land Warrior, incoming warning systems for aircraft, surveillance for reconnaissance and physical security, vehicle "lights-out" night driving, and, eventually, soldier infrared goggles.

2. PRECISION LASER MACHINING (PLM). The objective of the PLM project is to develop a new generation of precision laser machine tools for drilling, cutting, welding, and heat-treating a variety of mechanical and composite parts on manufacturing assembly lines. This technology is aimed at providing a capability for higher precision and greater tooling speeds than are currently available. Some specific goals are: brighter, higher quality laser beams that can target a work surface "spot" that is 5-10 times smaller, with an energy density 25-100 times greater than current lasers; higher peak power (25 megawatts versus the current 50 kilowatts) and higher average power (6 kilowatts versus the current 3 kilowatts for lamp-pumped solid state lasers); smaller packaging (20-40 cubic feet versus 70-150 cubic feet for available lasers); and lower maintenance requirements (maintenance intervals of 10,000-20,000 hours versus the current 500-1000 hours).

New tools and processes are being developed to enhance military engine component life and to improve fuel efficiency by more than 3% (saving about $400M per year). Through the implementation of more precise laser beams with variable pulse formats, manufacturers of aircraft engines will be able to drill holes with increased precision and reproducibility. The net benefits, to platforms like the F-119 engine on the YF-22 Advanced Tactical Fighter, are more efficient cooling, doubling of component life, and reduced life cycle cost of $100M per engine fleet. The use of high speed laser drilling of airfoil wings to reduce boundary layer drag will allegedly provide another 5% fuel savings.

The capability to cut graphite epoxy composites with minimal charring and delamination, applied to advanced low observable airframes and to platforms like the Comanche helicopter and the V-22 Osprey, is predicted to save more than $10M per airframe platform and to eliminate environmentally unsound cutting with abrasive water jets. Expanded use of composites will also provide significant fuel savings. Current welding methods on titanium wing box sections negatively affect fatigue life. PLM with fiber optic delivery will allow two-sided welding in areas that are difficult to access, resulting in the avoidance of current fatigue problems for platforms like the F-22. High power lasers with good beam quality and fiber optic delivery will enable in-situ laser welding and surface modification processes, providing major benefits to shipbuilding and maintenance. In-situ maintenance and repair processes include: welding of tubes and pipes, cladding of valve components on nuclear submarines and aircraft carriers, and heavy-section repair through the addition of filler material.

3. Autonomous Landing Guidance (ALG). This is an effort to reduce the risks of delays and diversions that poor visibility may cause. The ALG System will allow pilots to land their aircraft in fog, smoke, and other obscurants. The team has several key ingredients. Northwest Airlines has the responsibility to ensure commercial interest and viability. Lear, as a defense contractor providing the keystone technology, can take ALG to the final product manufacturing line, both for commercial and defense units. The IR feature is being developed by a small company, FLIR Systems. The Air Force and NASA are contributing sensor fusion knowledge to combine the radar and IR into an “all-weather” seeing capability. The system is mounted on the “Speckled Trout,” a 707 aircraft that serves the Air Force Chief of Staff. It is being tested during worldwide flights, under the direct view of the top airman. This unique connection with the military user is a result of discussions between the consortium, Wright Laboratories, and the 412th USAF Test Wing, which resulted in a CRADA for support and testing of the systems with the 412th. With ALG, pilots fly the aircraft with information displayed on their heads-up display (HUD). The display gives the pilot all the performance data needed for flying and landing the aircraft. An integrated complement of weather-penetrating sensors, including a revolutionary millimeter-wave imaging radar coupled with infrared sensors, is mounted on the aircraft. These sensors provide a visual image of the runway overlaid on the HUD, so the pilot can see through the weather with all aircraft performance information within the same out-the-window viewing area. If this program is successful, pilots will be able to land in CAT IIIA low visibility on CAT I equipped runways, reducing the constraints of weather on operational planning. There are important benefits in situations like Desert Storm. ALG will permit low visibility tactical operations and transport fleet operations in bad weather — sometimes, even making poor weather an ally by denying enemy operations while ours continue. Military missions flown under the cover of clouds and fog will also deny the enemy use of electro-optic systems. Using this technology in both commercial and military markets is expected to significantly lower unit costs for the military.

4. CASUALTY CARE. Studies show that a large number of combat zone casualties must be diagnosed and receive care during the first hour after being injured, or their chances of recovery are poor. The percentage of wounded who survive this "Golden Hour" has not changed since the US Civil War. Major reasons for this are the difficulty of extracting, storing, and transmitting diagnostic information and obtaining expert medical advice under battlefield conditions. Enhancement of emergency and combat care is being accomplished by: (i) exploiting information management and networking technologies that will make telemedicine a reality on the battlefield, and (ii) developing new technology devices for biosensing human physiological parameters and for organ systems diagnosis. These sensor suites and information systems aid the diagnosis of injuries, measure and monitor medical status and treatments, and maintain information about the wounded soldier from the battlefield to the aid station and all the way to hospitals in the US. Systems can indicate which troops need immediate medical attention, transmitting triage data ahead to allow MASH units and field hospitals to prepare for incoming casualties. The capability for continuous and non-invasive sensing of vital signs and body chemistry to develop remote diagnosis, to virtually place the physician at the side of the wounded soldier, is crucial to saving lives in the combat zone. The resulting capabilities, which broadly apply to combat casualty care and wound healing monitoring, also greatly enhance diagnosis and monitoring of civilian trauma, disease, or pathology. The civilian medical counterparts of combat care are shock and trauma and emergency treatment. Locating and treating victims of accidents or crime is a difficult endeavor, even without the dangers of the battlefield. The technologies featured in casualty care respond to those difficulties in several ways. The utility of a medical communications system with data storage and processing capabilities and compatibility with a number of important sensors (as diverse as the Global Positioning Sensor [for finding the injured person] and medical monitoring and diagnostic sensors [which allow early and constant updates on the victim's condition]) is undeniable for the civilian trauma care center. Diagnostic aids and medical history availability at a civilian accident site is as important as it is on the battlefield, as is meaningful communications with a remotely located expert. The hospital emergency room needs advanced information to gather the proper resources and skills just as surely as the military medical unit. The similarity of these needs between the military and civilian communities forms the justification for this important dual use area.

ANNEX E.

THOUGHTS BY THE MILITARY AND INDUSTRY PANEL ON THE US MARKET AND THE PRODUCT DEVELOPMENT PROCESS

1. The Nature of the US Market. A conceptual model of the US market was constructed, in order to build an understanding of the dynamics of the marketplace (see Figure E.1.). In the upper left hand side of this figure, plots of GDP and defense budgets are shown for the period 1960 to 1994. A 28.3% GDP growth occurred between 1989 and 1994 (in 1989 dollars), as compared to a 7.2% reduction of the defense budget during the same interval. If one chooses a point in time, say 1985, and looks at the "shape" of the military and commercial market (i.e., the output of US industry), military as well as commercial, a curve like the notional one in the right-hand chart can be drawn. The entire US market is represented conceptually as the area under this curve. The military market share is defined by arranging the products according to the degree of military interest along the abscissa.

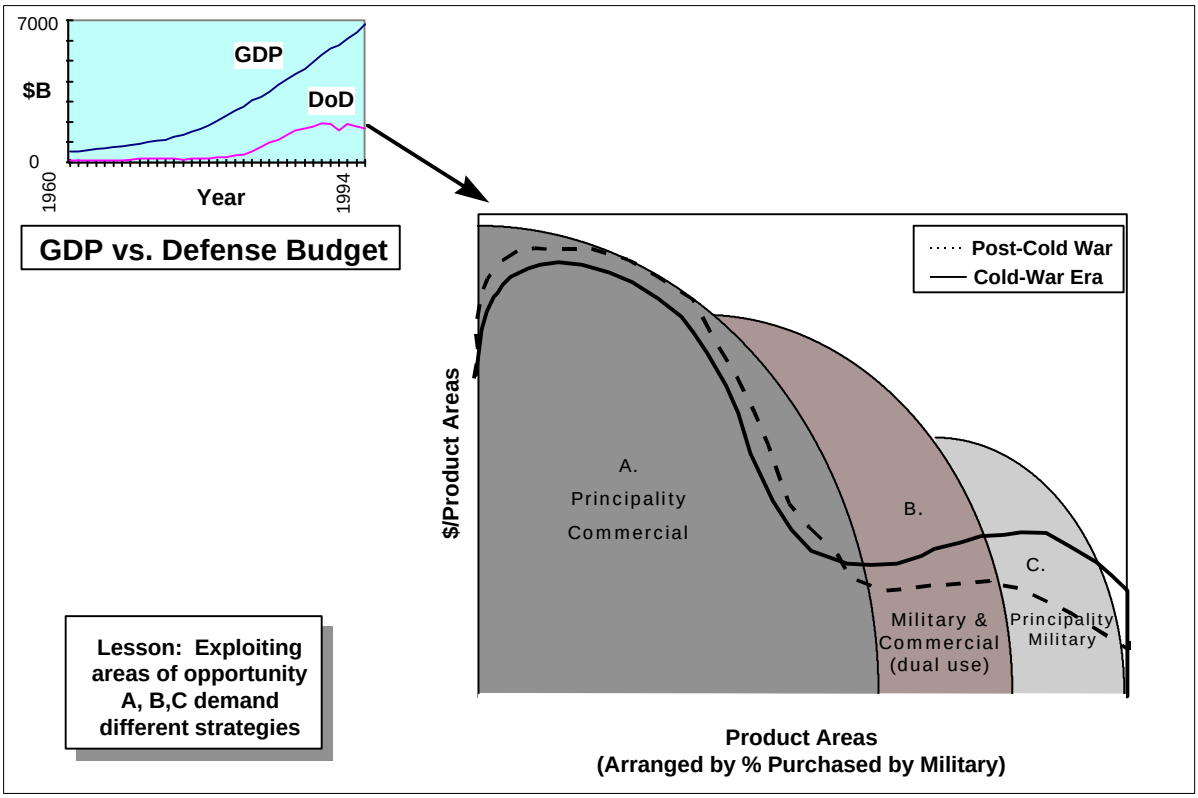

FIGURE E. 1. A SCHEMATIC REPRESENTATION OF THE US MARKET

Area "A" in the plot consists mainly of commercial commodities, a relatively small percentage of which finds its way into military use. This area is strongly dominated by commercial markets and has become less and less interested in DoD business for at least three reasons.

- The DoD represents a progressively smaller part of the total market.
- DoD is seen as having unique requirements that do not usually fit into the commercial/industrial/consumer world.
- DoD is generally viewed as a troublesome and expensive customer because of inordinate paperwork, how-to specifications, and audits and inspections.

Post-cold war downsizing (indicated by the dotted curve, notionally representing 1994) has had little effect on market volume. In fact, the market value of Area A has actually increased, due to the growth of the global marketplace. It is obvious that the military will have difficulty influencing the industries serving this segment of the market. In order to take advantage of a larger portion of this market the military must change toward becoming a better customer.

In Area "B," the market is generally more responsive to dual use. Here, the DoD addresses a larger percent of the total market and industry accommodation can be expected to some extent, although there should be no expectation that the commercial customer will be sacrificed for gain in the military sector. It is in this area that TRP has been most innovative, making deals that improve viability of meeting both military and commercial objectives. In this portion of the market, post-cold war budgetary cuts are felt, but industry's reaction may well be to concentrate more exclusively on their commercial customers to the detriment of the DoD.

Area "C," consisting of predominately military commodities, is where the DoD holds greatest sway over industry. Here an objective may be to keep industry alive and productive for the military by selective commercialization of military commodities. This may be a welcome strategy for many defense companies devastated by DoD post-cold war budgetary cuts. Clearly, post-cold war business is down in this market area.

Insights into several aspects of dual use are possible through this conceptual model. For example, one can envision most components of the Army's M1 tank being produced all along the abscissa after a dual use initiative, where now nearly the entire major item comes from the far right side of the market curve (Area C).

2. Notional Product Development Process. The next three figures represent an attempt to look more closely at the nature of the US market, narrowing down to the product itself. In any product development process — whether military, commercial, domestic, or international — one can imagine a notional flow that starts with the concept of what's to be done (e.g., "What will sell?" "What does the military need?"). The output of this process is a requirement. On the commercial side, this phase is called "Market Analysis" (on the military side it may be called "Capability Studies"). In industry, this market analysis may be done *very* rigorously (e.g., deciding whether to build a 777 or a supersonic transport) because the fate of an entire company may hinge on the product decision. If a state-of-the-art product is being considered, a research project is typically involved. The product of that research is "technology." "Research" and "technology" here refer to both *processes* and *products*. Once the technology is developed to the point where it has inherent utility, it is applied in some fashion and becomes "productized" for a purpose (i.e., the technology application becomes a prototype). Ultimately, this prototype is brought into production.

The horizontal, labeled arrows (which we refer to as "products") depict contributions to a "knowledge domain."` For instance, when a market analysis is performed, the work not only feeds the product cycle, but the analysis becomes part of a broad domain of knowledge (whether proprietary, classified, public, or close-hold). The work that is done at each step in the development cycle is useful not only to the product, but as a "feed" to this body of knowledge. There are hundreds of thousands of such processes at various stages of completion in the commercial world and a large number in the military world.

This, then, is our model, displayed schematically in Figure E. 2. At each level, knowledge is developed: some is proprietary, some is close-hold, some is in the public domain. At any given point in the notional process, whether you speak of a toaster, a tank, a plane, or a launch vehicle, you can imagine this same characteristic flow pattern.

There is value to the military at looking at this process at every one of the levels shown. If opportunities appear at the top of the chart, one must then find ways in which these opportunities can flow to a product. It should also be stressed that there are factors other than the lowest-cost issue that bear on the "Make-or-Buy" decision (e.g., time-to-market, military specifications).

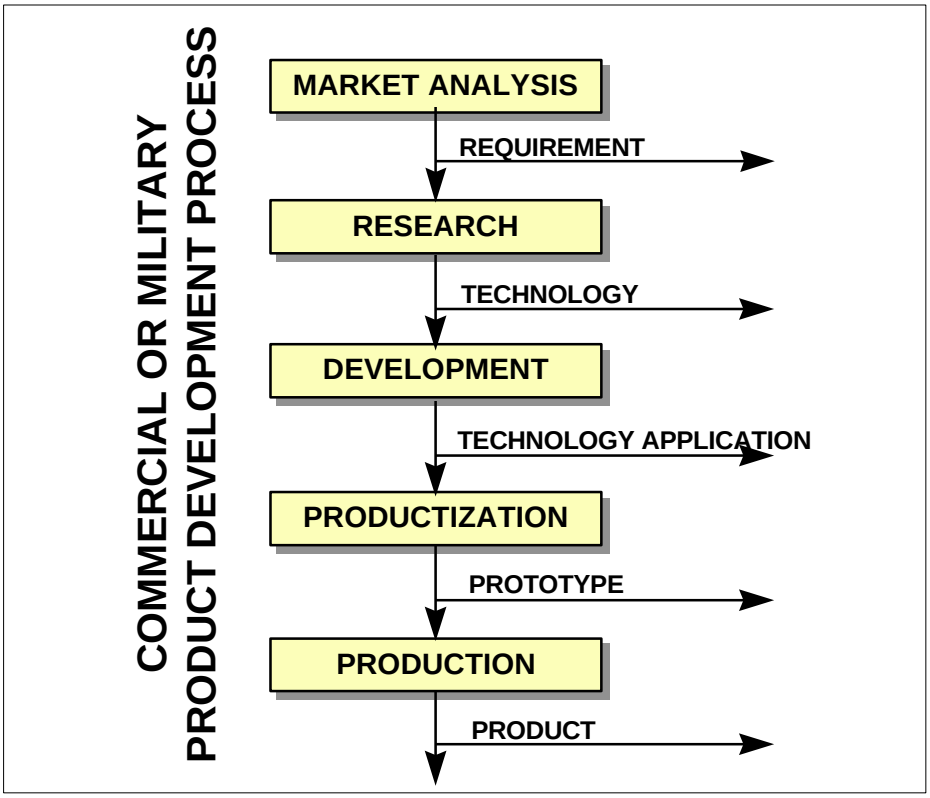

FIGURE E. 2. NOTIONAL PRODUCT DEVELOPMENT PROCESS

3. Dual Use Relationships between Commercial and Military Product Cycles. We draw from the discussion above to consider commercial and military product development. In both commercial and military product cycles, there is a series of "make-or-buy"-like decisions that have to be made. The dual use question can be reduced to one of changing the factors that bear upon the "make-or-buy" decision.

The commercial product cycles currently underway involve roughly an order-of-magnitude greater expenditure than the military product cycle developments. There are, comparatively speaking, a few military system designers (working on the right hand side of the Figure E. 3.)

who would like to reap the benefits of what's going on in the commercial world (the left hand side of the figure). Much commercial activity may not appear to be relevant to the military. For instance, the military doesn't need a "Speak-and-Spell" toy. However, when one breaks down the commercial process that yields this toy, one discovers a low-cost microchip, computer speech, i/o techniques — some of which *might* be relevant to the military. In other words, when examining the work breakdown structure of commercial products, one asks whether there are components or research or development that may be relevant to the military. So when a military system is built, one must ask, "In order to make this product optimally, what must I do, and how can the commercial sector enable me to do it?" The challenge at every point is to buy a commercial product in order to reap the benefit. If this cannot be done at the commercial product stage, are there applicable commercial developments that can be utilized, or research findings? The benefits of commercial activities should be exploited by making intelligent Make-or-Buy-like decisions at every stage of the development of a military product.

These make-or-buy-like decisions become the core of dual use. We note that, in some instances, "buy" may involve proactive, direct influence by the government in the commercial world e.g., research. (TRP, for instance, encouraged co-mingling of activities in the development/productization phases of both commercial and military product cycles; its domain is indicated schematically by the shaded region.) When this has happened, those who perform the make-or-buy decisions throughout DoD will be knowledgeable of what's available in the commercial sector — US and worldwide. Second, they will be able to determine the benefits to be derived if DoD draws from commercial activities for use in our military products (technology/capability insertion). At bottom, make-or-buy-like decisions will be made in a very different way than they are now — to enable taking greater advantage of commercial activities.

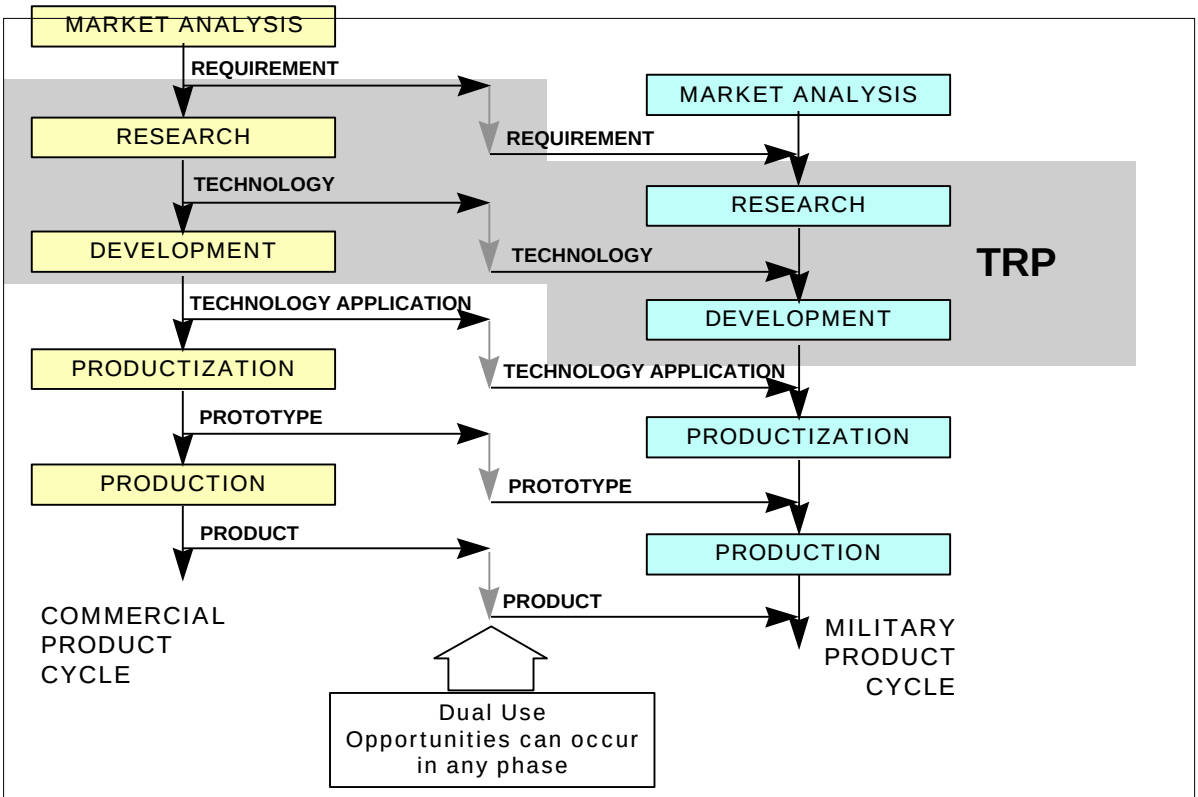

FIGURE E. 3. DUAL USE RELATIONSHIPS BETWEEN COMMERCIAL AND MILITARY PRODUCT CYCLES

The overall lesson is the flow which can occur from the commercial product development to the military utilizing dual use opportunities. At any level in the development process, the commercial item can move into the next phase of the military process, perhaps with modification to ensure utility.

4. Notional Work Breakdown Structure for Dual Use Systems. It is important to remember that these technology developments may apply to any level of the product/system work breakdown structure, as notionally shown here. Any system is made up of an array of segments — the classical Work Breakdown Structure shown in Figure E. 4. Although it may be the epitome of the military system (bomb, tank, ship), as one goes down through the subsystems, one begins to find commercial products (nuts, bolts, subsystems, flat panel displays). So there are some components of every military system that derive from the commercial sector. Therefore, every military system contains some commercial components. As discussed in Figure E. 3, a "make-or-buy"-like decision is made with respect to every one of these components/boxes/subsystems, wherein the question is asked, "Can I make it or can I buy it? What is best for the overall objectives for my system?"

Military developers in the past have been biased toward a special-purpose military "make" decision because the military accustomed to building military-unique systems requiring a great deal of research, development, and productization. Now, budgets are tighter in this post-cold war era, technology is moving more rapidly in commercial sectors, and the world has changed. We no longer either need — or have the resources for — the kind of research, development, and productization that is military-unique. So the "make-or-buy" decisions today need to be biased, to a greater extent, toward "Buy" from the commercial sector.

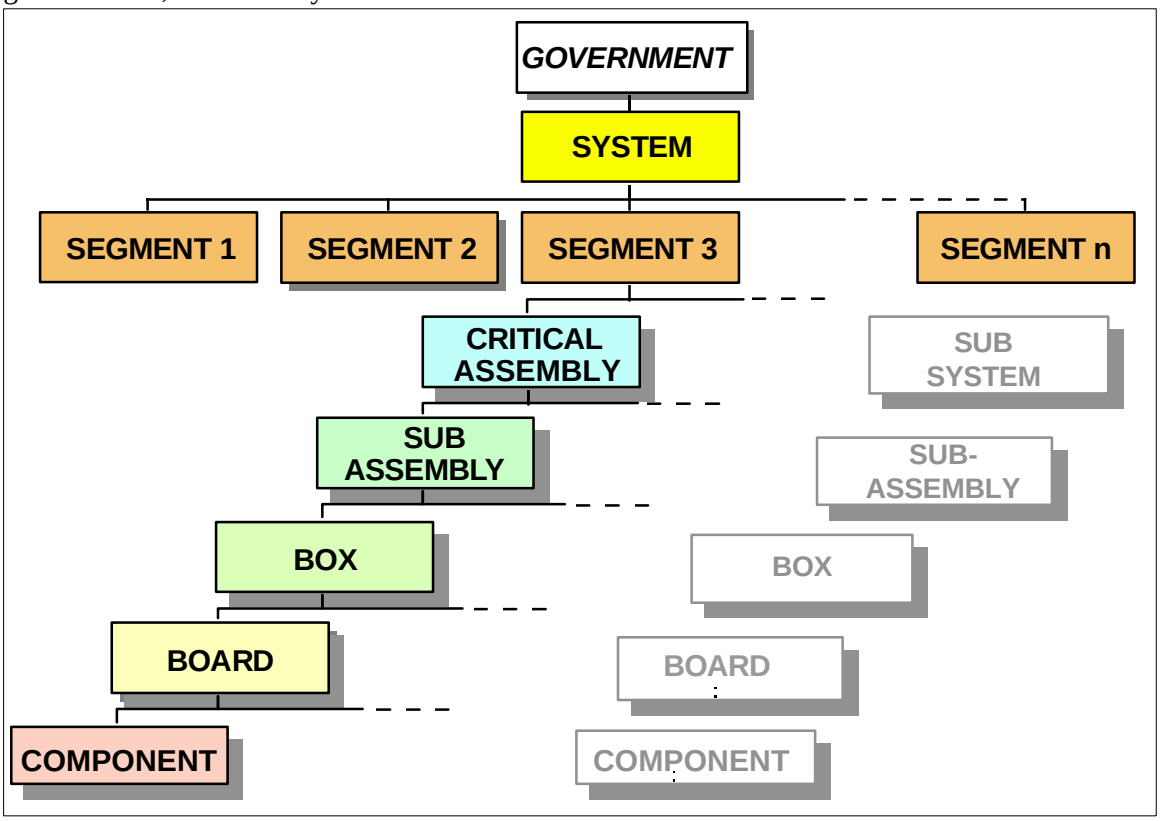

FIGURE E. 4. NOTIONAL WORK BREAKDOWN STRUCTURE FOR DUAL USE SYSTEMS