Management and Introduction of Technology - An OSD Office of Technology Transition Perspective For Effects Based Support in the New Security Environment

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ABSTRACT

In the day-to-day office arena, routines are regularly impacted with requests for nominations for many different development programs. A Program Manager may consider these calls and requests for nominations as an additional burden on their already taxed and stretched thin schedule of time and resources. Even so, these programs play an integral part in reducing and sharing risks, leveraging scarce resources from several sources, and potentially leading to development and delivery of new and/or improved capabilities to the war fighters faster and at less total ownership cost (TOC) for them and the Nation.

This paper will present an OSD architectural overview of how the Office of Technology Transition programs fit together and assist not only the war fighter, but our Services Program Managers (and the Services), along with our industrial and commercial partners. These programs collectively reduce and restructure risks, leverage resources and ideas from multiple sources, and are all aimed at delivery of increased capabilities (and reduced costs) to the number one customer, the front line war fighters. More importantly, these programs are additional avenues and paths for development and introduction of new technologies, even if most of them are NOT directly identified within specific budget lines and program elements. These programs are the door openers for getting to that point of making contributions to the war fighters, while at the same time allowing our scientists and engineers to perform in their areas of expertise.

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASD – Assistant Secretary of Defense
ASNE – American Society of Naval Engineers
AI – Acquisition Initiative
AR – Acquisition Reform
C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
C-Cs – Combatant Commanders
CD-ROM – Computer Disk-Read Only Memory

CONOPs – Concepts of Operations
COSSI – Commercial Operations and Support Savings Initiatives
CRADA – Cooperative Research and Development Agreement
DARPA – Defense Advanced Research Project Agency
DDR&E – Director, Defense Research and Engineering
DII – Defense Information Infrastructure
DIS – Distributed Interactive Simulation
DLAMP – Defense Leadership and Development Program
DOD/DoD – Department of Defense
DOTMLP-F – Joint **D**octrine, Agile **O**rganizations, Joint **T**raining, Enhanced **M**aterial, Innovative **L**eadership and Education, High Quality **P**eople, and Requisite **F**acilities
DPA – Defense Production Act
DUAP – Dual Use Applications Program
DUS&T – Dual Use Science and Technology
EMALS – ElectroMagnetic Aircraft Launch System
EPA – Education Partnership Agreement
E.U. – European Union
F/A – Fighter/Attack
GPS – Global Positioning System
HPFZ – High Purity Float Zone
HUMS – Health and Usage Monitor System
IMU – Inertial Measurement Unit
IR&D – Independent Research and Development
JDAM – Joint Direct Attack Munition
JSOW – Joint Stand-Off Weapon
JV – Joint Vision
ManTech – Manufacturing Technology
NII – National Information Infrastructure
O&S – Operations and Support
OE – Operational Engineering
OSD – Office of the Secretary of Defense
OTT – Office of Technology Transition
PLA – Patent License Agreement
PMO – Program Management Office
PSSD – Power Semiconductor Switching Devices
QDR – Quadrennial Defense Review
R&D – Research and Development
RBA – Revolution in Business Affairs
RMA – Revolution in Military Affairs
SBIR – Small Business Innovative Research
SOI – Silicon-On-Insulator
S&T – Science and Technology
T2 – Technology Transfer
TTPs – Tactics, Techniques, and Procedures
TOC – Total Ownership Cost
TRP – Technology Reinvestment Program

UAV – Unmanned Aerial Vehicles
U.S.C. – United States Code
USD(AT&L) – Under Secretary of Defense for Acquisition, Technology and Logistics
USS – United States Ship

INTRODUCTION

The new DoD 5000 series guidance continues the efforts to modernize and improve the process of how combat systems and weapons systems are developed, acquired, fielded, and supported. The new Joint Vision (JV) 2020 expands the precepts of JV 2010 by emphasizing the re-engineering and restructuring of our military forces and methods for engaging and countering threats to our national security as the 21st century unfolds. These documents highlight the opportunity for closer coordination and support between the military forces, the civilian and industry work forces. One of the critical interfaces is the technology, maintenance, and logistics support provided via the headquarters organizations to those in the field, the war fighters and Combatant Commanders (C-Cs).

In fact, the newly released DoD Quadrennial Defense Review (2001) addresses technology transformation in several respects, among them:

- DoD will *rely on the private sector to provide much of the leadership in developing new technologies*. Thus, the Department has embarked on . . . This “quiet revolution” [which] will *take advantage of science and technology and continue to provide U.S. forces with technology superiority*. [QDR, 2001, p. 41] (Emphasis added.)

Thus providing support to the four defense policy goals of: a) Assuring allies and friends; b) Dissuading future military competition; c) Deterring threats and coercion against U.S. interests; and d) If deterrence fails, decisively defeating any adversary. [QDR,2001, p. 11]

Background

In this paper the author will discuss the specific technological opportunities that are available (from the Office of Technology Transition perspective) to the maintenance, logistics, and technology communities and link them to the evaluation of the technological decisions and products being provided to the war fighter through an evolved systems engineering environment – Operational Engineering (OE) environment. [Bryant and Flynn, 2000. p. 101-119.] [Flynn and Bryant, 2001] Along with several other continuing efforts (Acquisition Reform / Initiative (AR/AI) and Revolution in Business Affairs (RBA)), technology implementation and innovation is an important component in the maintenance and sustainment of high tempo, rapid decisive operations in the 21st century. The Operational Engineering environment

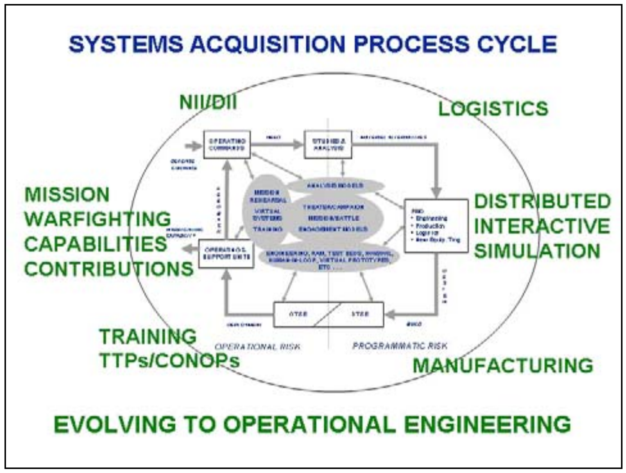

Figure 1 – Operational Engineering Includes Systems Acquisition

includes the technology support intrinsic to developing and fielding systems, with their included operational capabilities delivery, based on the war fighters involvement in evaluating tactics, techniques, and procedures (TTPs), and concepts of operations (CONOPs), against the war fighters' operational requirements framework of evaluation. (Please see Figure 1.) [Piplani et al, 1996] Improving and growing computer communications networks, coupled with the associated modeling and simulation capabilities, foreshadow improved coordination and decision making between the headquarters organizations and the war fighters and C-Cs utilizing the National Information and Defense Information Infrastructures (NII/DII), and lend support to this Operational Engineering environment. Technology enters into the environment through the materiel alternatives, the evaluations performed via the Program Management Office (PMO), the Distributed Interactive Simulations, and the manufacturing efforts (as examples) to be evaluated against the contributions to the mission warfighting capabilities of our war fighters and C-Cs. These efforts are in line with the 'quiet revolution' of the QDR. They are rife with possible problems, yet also with the potential for many solutions as well.

PROGRAM MANAGER PERSPECTIVE

The routine day in the office of a Program Manager is filled with many requests for time and attention. These requests come from within, associated with basic administration of the group, and from the numerous organization stakeholders – internal and external. Aspects of this demand level are seen in the central section of Figure 1, within the Program Manager Office (PMO), and the interactions with other parts of the Systems Acquisition Cycle. While the PMO functions are denoted as engineering, production, logistics, and new equipment training, these areas only begin to touch on the myriad of details and interactions which are involved with the lesser and still included pieces, along with the individuals and organizations which may actually be performing those function as the direct agents of the PMO.

The larger aspects of Operational Engineering is denoted by the larger encompassing environment that specifically addresses the larger aspects of PMO functions evaluated by the war fighters (and external stakeholders) in their frame of reference of assigned missions of their C-Cs in the international arena.

The Program Manager sometimes must respond to yet another environment which is just as demanding, if not in some perspectives, more demanding. It is one which includes the stakeholders of the remainder of the Executive Branch (for items like National Security Strategy, National Military Strategy, budget compilation and forwarding, cross service coordination, etc.); the Legislative Branch (for approved budgets, requests for progress reports, regulations, some directions, etc.); and, the Business/Industry community (for production of product and its support). One depiction of this arrangement is known as the Iron Triangle, sometimes also known as the Tortured Triangle, because of all the reports, tasking, directions, funding, and regulations interactions. It is sometimes denoted as similar to the representation in Figure 2. [Schnoll, 1996] In this view, users and allies get depicted as being somewhat in the outside of the paths of interactions of the triangle. For this reason the war fighter is considered more included within the OE environment due to the employment of connectivity for interaction and simulation via the NII/DII, and the Distributed Interactive Simulation (DIS) capability. (These interaction components are increasingly available to more and more of the stakeholders involved in both of the environments depicted in Figures 1 and 2 because of the degree of continued connectivity evolution.)

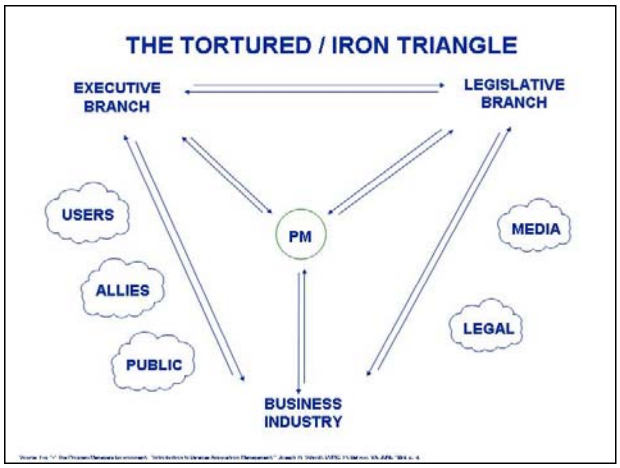

Figure 2 – The Program Manager's Tortured / Iron Triangle

These levels of interaction are not indicating that leadership of or in a PMO is impossible. It is more to point out that leadership and management of all the components and interactions associated with the support, development, and delivery of the war fighters, equipment, and capabilities are quite complex and challenging just because the program office must be able to conceive, develop, produce, support, improve, maintain, and ultimately dispose of the products. It takes not only the program office and its people, but all the people with all their interactions to produce the products and capabilities. That production has been characterized as taking too long and costing too much for delivered capability [Ratnam, 2002]. The Revolution in Military Affairs (RMA) literature as discussed, analyzed, and reported in business and government have many ongoing discussions of this also. Some discussions focus on the technologies, some focus on the organizations, and some focus on the doctrine and procedures. Some challenging discussions link these all together in a triumvirate similar to the triad of Clauswitz composed of the population – government – military. The Program Manager, like the commanding officer in the field or the business Chief Executive Officer, balances all the pressures and tasks of their organization, while likewise paying attention to the needs of that organization while it functions and operates. The leader faces the challenge of leading, interacting, and managing all at the same time both directly and indirectly.

One of those sets of tasks which come along on a regular basis (yet are sometimes considered outside interference) are the requests and calls for nominations for those programs which are collected together at the OSD level within the Office of Technology Transition (OTT). These programs are aimed at attempting to make the cost of the systems less and also consume less time for delivery to the war fighters – both key goals of the Revolution in Military Affairs (RMA) / RBA and the AR/AI efforts of recent years. (That task is also mentioned in the 2001 QDR.) These OTT programs will be discussed following a review of the larger OSD environment and guidance along with technological change and associated impacts in other areas like organizations doctrine.

CONNECTION TO OSD ASPECT

With the issuance of the DOD 2001 QDR and the appointment of RADM Cebrowski as the Assistant Secretary of Defense (ASD) for Transformation, the discussion and debate regarding military transformation, evolution, and revolution has now received a strengthened addition to the roster for focusing and melding the several services efforts and objectives. The Army is working toward the Objective Force and Future Combat System via the XVIII Airborne Corps and Interim Combat Brigade Teams. The Air Force is moving into its Air Expeditionary Force and more recently toward aspects of a Space Force. The Navy is beginning to move toward increased emphasis of its Forward Deployed Naval Force mission, along with the Navy After Next with its ideas of supporting the expeditionary aspects of the services future capabilities. The Navy is joined in this effort with its Naval teammate, via the efforts represented by the Operational Maneuver From The Sea, Ship to Objective Movement, and most recently Expeditionary Maneuver Warfare doctrine statements of the U.S. Marine Corps.

These efforts can, must, and may work together and independently as building blocks for employing the transformation of the Services capabilities in execution of National power. This has most recently been highlighted by special operations forces in Afghanistan operating with indigenous forces and allies as mounted cavalry (horse back), using modern technology (communications and computers) to pass on targeting data to Air Force and Navy aircraft for delivery of bombs and ordnance in as little as ~15 minutes from radio call. That effort represents a transformation, as well as a revolution in delegation, when compared to previously employed mechanisms and processes in other operations and locals. It foretells potential benefits as well as potential changes when considering what must take place to implement, track, and lead adjustments and changes in delivery of capabilities which recently have been termed the Revolution in Military Affairs (RMA).

Fitzsimmons and Van Tol [1994], provide a discussion and framework for assisting in riding the beast of RMA. As depicted in Figure 3, one representation of RMA is a pyramid composed of three segments: Technology, Organization, and Doctrine changes. These three segments are on a foundation of the Joint **D**octrine, Agile **O**rganizations, Joint **T**raining, Enhanced **M**ateriel, Innovative **L**eadership and Education, High Quality **P**eople, and Requisite **F**acilities (DOTMLP-F) of JV 2010/2020. All the Service progressions outlined above

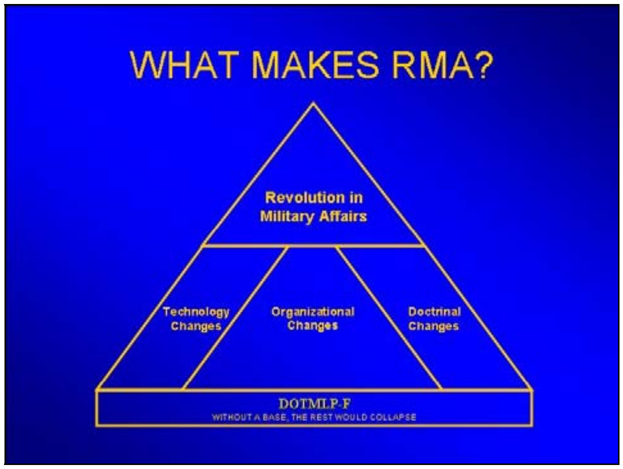

Figure 3 – Components of the Revolution in Military Affairs

are addressing these 3 segments of the RMA internally and externally, while individual program mangers are addressing the environment of their execution in the Iron Triangle framework. As seen historically with the introduction of aircraft carriers, amphibious operations experiments, and combined arms (blitzkrieg) during the years between World War I and World War II, all three segments (technology, organization, and doctrine) interacted to produce significant change and adjustment to previous organizations and doctrine.

Currently, with the QDR points, along with the USD (AT&L) goals, and the DDR&E priorities as summarized in Figure 4, some added understanding of how the transformation and RMA components can work together synergistically are available to not only the leaders, but the implementers, and the ultimate receivers of the products, processes, and weapons systems that are produced. The components can work together to meet multiple goals and objectives, allowing improved evaluation of efforts and decisions associated with programs, projects, and design decisions when evaluated within the Operational Engineering environment against the delivery of capabilities to the war fighters for execution of their assigned missions.

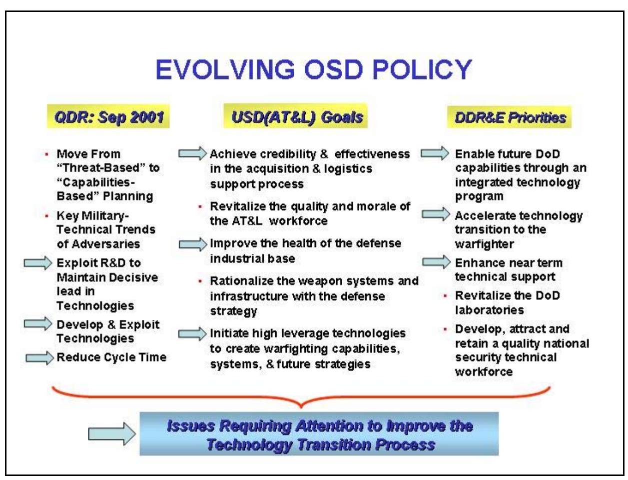

Figure 4 – Context of Evolving OSD Policy

For example: Technology enters into the acquisition cycle through the Program Management Office segments of Engineering, Production, Logistics, and New Equipment Training; through Operations and Support, and even aspects of the material alternatives. In the OE aspect it also is present in the large Distributed Interactive Simulation network, along with the manufacturing efforts (as examples) to be evaluated against the contributions to the mission warfighting capabilities of the war fighters and C-Cs. It is through the several OSD programs and projects that these efforts all merge and potentially assist one another as will be shown via the following discussions of the Office of Technology Transition programs and examples.

The QDR 'quiet revolution' intent expresses the hope for technological opportunities and solutions, but they can not be considered in isolation from doctrine and organizations. That revolution must also address the long and arduous cycle time of acquisition and delivery of capabilities into the warfighters hands. At the same time, retired VADM Cebrowski, Director, Office of Force Transformation, notes that "a certain amount of patience is involved,' when considering actions to take regarding promising areas for transformation and delivery of capabilities. [Kaufman and Svitak, 2002]

THE OFFICE OF TECHNOLOGY TRANSITION INTERFACE AND MIXING BOWL

The Office of Technology Transition operates under Title 10 Statutory authority (10 U.S.C. § 2515) – the programs that have been associated with the Office all have Congressional directions and are directly related to the overall acquisition cycle. The OTT serves as the focal point or mixing bowl for DOD's domestic technology transfer activities with the Services and Industry. It provides further direction "that the head of the office will ensure that the office will monitor research and development (R&D) activities of the Department of Defense; identify R&D activities that result in technological advances that have potential for nondefense commercial applications; serve as a clearinghouse for, coordinate, and actively facilitate the transfer of such technologies and technological advancements to the private sector; conduct its activities in consultation and coordination with the Department of Energy and the Department of Commerce; and, provide private firms with assistance in resolving problems related to technology transfer."

The programs associated with DOD domestic technology transfer efforts are all associated with the different sections and stages of the complete systems acquisition product / process life cycle. Thus, as introduced previously, they also are within the Operational Engineering environment and can potentially be assessed by their contributions to the delivered war fighting capabilities of the C-Cs and their forces.

The OTT's programs and efforts will be introduced and discussed in the following sequence: Dual Use Science and Technology (DUS&T); Independent Research and Development (IR&D); Small Business Innovative Research (SBIR)[Author's note: Recent Office restructuring has shifted SBIR reporting chain – though in context it still fits within the Office functional context.]; Manufacturing Technology (ManTech); Defense Production Act (DPA) / Title III; Commercial Operations and Support Savings Initiative (COSSI); and, Technology Transfer (T2). (Structure of each section will be: Short Program description and goals; Naval / Commercial example; and, interests / impact of the program / example.)

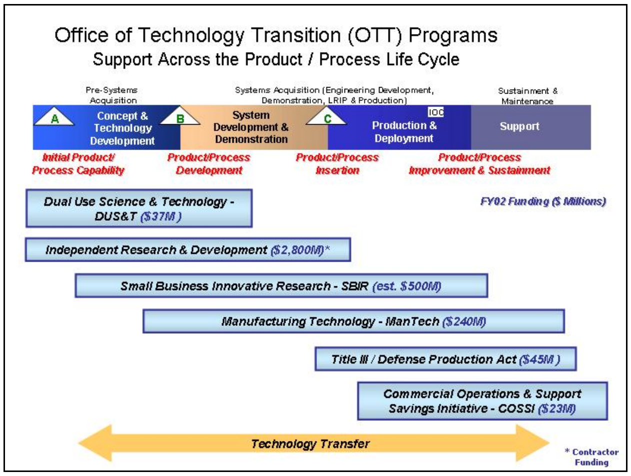

Figure 5 – OTT Programs - Support across the Product / Process Life Cycle

Prior to discussing these programs, it is worth going back to the statement of intent that "the mission of the Defense Science and Technology (S&T) program is to ensure the warfigthters today and tomorrow have superior and affordable technology to support their missions, and provide revolutionary war-winning capabilities . . ." [Aldridge & Etters, 2001] so that the war fighters are prepared for supporting "the four defense goals of: assuring allies and friends; dissuading future military competition; deterring threats and coercion against U.S. interests; and if deterrence fails, decisively defeating any adversary" as stated in the QDR. [QDR, 2001, p. 11.] Thus, like the other DOD programs and projects, the Programs of OTT represent a continuum of opportunities or tools for introducing improvements and transitioning technology during the complete lifetime of the project or system as shown in Figure 5. In a sense, this family of efforts truly embodies the principle voiced by Tom Peters [1987, p. 229-236] referred to as 'creative stealing', drawing ideas from all possible sources for adaptation, improvements, and new applications. The family of efforts allows this principle to be employed throughout the complete lifecycle of the weapons system. [Author's Note: Descriptive material in the following seven sections is compiled from the 'Report to Congress on the Activities of the DoD Office of Technology Transition' for reporting years 2000, 2001, and 2002. DOD OTT, 2000; DOD OTT, 2001; and, DOD OTT, 2002.]

Dual Use Science and Technology (DUS&T)

The DUS&T Program has its origin in the Technology Reinvestment Project (TRP) ('93-'96) under DARPA, then evolved to the Dual Use Applications Program (DUAP) ('97-'98) managed jointly by DARPA, DDR&E, and the Services. The 1998 Defense Authorization Act established the DUS&T Program as the next generation effort, with the objective of partnering with Industry to jointly fund the development of dual use technologies needed to maintain DOD's technological superiority in the battlefield; and, by Industry to remain competitive in the market place.

The tenets of the DUS&T Program are: cost sharing between the Military Services and Industry (the traditional and non-traditional vendors); use of 'other transactions' and 'cooperative agreements' in lieu of standard contracting, to attract commercial firms (and remove some of the roadblocks to potential innovation); and, the formation of partnerships with Industry to develop dual use technologies. (Note: Dual use technologies are those which have both commercial and military applications and uses. Because of this, both DOD and Industry enjoy the opportunity to leverage limited R&D funds for jointly larger returns on investment and shared risks.) DOD can take advantage of the competitive pressures and market driven efficiencies inherent in the commercial sectors. While not without risk of failure, the opportunities are present for both Government and Industry to experience 'win-win' outcomes.

Example: The Second Annual DUS&T Achievement Award has gone to the Navy's Thermal Spray Nanostructure Coating Project. This project was initiated in 1997 to develop highly wear, erosion, and corrosion resistant nanostructured coatings for use in ship, aircraft, and land vehicles. [DOD OTT, 2000, p. 17, and DUS&T Award nomination package.] The application process utilizes existing industrial equipment and standard thermal spray processes to apply the developed ceramic composite coating which meets the objectives of the project.

The primary benefit of this technology is a reduction in life cycle costs through increased corrosion and wear protection. In addition, thermal spray coatings are superior to hard chrome plating and are about 60% less expensive due to the reduced cost of complying with environmental regulations. Navy applications for this technology are well underway and include air intake and exhaust values for submarines that is expected to save $400K/ship or $20M over the next ten years. It was also used on the USS George Washington's electric motor and oil pump shafts; and, will be used for the main propulsion shaft for mine countermeasure ships resulting in a $1M/year savings per ship.

The technology is also transitioning into commercial products. Warren Pump is using the technology to manufacture screw pump rotors for commercial gas turbines and fuel feed pumps and the technology is also being used on water pan rolls for the printing industry. Inframat - the contractor for the project - has formed a new company, Nanopac, to pursue new opportunities. Ultimately, the Services' benefits of this technology will be realized by reduced TOC for submarines, surface ships, and aircraft.

Through this award winning example, the door opens to the potential applications of this technology for other commercial and Services uses in support of improved maintenance cycles and cost reductions. The uses cited also point out that while the technology has military applications, the commercial side does a great deal of the military's maintenance, thus supporting the direct application to commercial practices and the spread of the technology.

Currently, the DUS&T Program has had more than 300 projects initiated, with a total value of over $1 billion invested. Additionally, more than 400 companies, universities, and nonprofit organizations are or have been participating in the program. The military services participation has been key to the DUS&T Program's success, and supports the effort of making DUS&T a normal part of the acquisition process as mentioned by DODD 5000.1 when it states ". . . program managers shall first consider the procurement of commercially available products, services, and technologies, *or the development of dual-use technologies* to satisfy user requirements. . ." (emphasis added) [DODD 5000.1, 2001, § 4.2.3.]

Independent Research and Development (IR&D)

Independent Research and Development is R&D initiated and conducted by defense contractors independent of DOD control and without DOD funding. As alluded to previously, and depicted in Figure 6, the national Non-government R&D funding has been increasing compared to the Federal R&D funding. Further, when taken together, U.S. commercial, plus the E.U. and Japanese Research funding is approximately 2 ½ times the total U.S. Government research base investment. Thus, it makes sense to attempt to leverage IR&D investments. In fact, 10 USC § 2732 (c) (3) provides for reasonable and timely communications of (1) DOD's planned or expected future needs to contractors, and (2) contractor's progress on IR&D programs to DOD. These IR&D efforts can be characterized as improving overall IR&D management and communications with Industry.

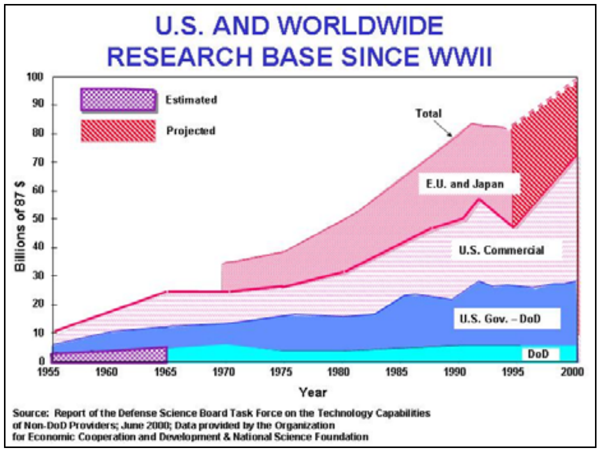

Figure 6 – U.S. And Worldwide Research Base Since WWII

To state this another way, there are three DOD /Industry interactions: 1) DOD provides information on its R&D activities and plans, missions needs, and operational requirements to assist Industry in its planning, funding, and conducting of IR&D efforts within its business plans; 2) while Industry provides technical information about it's IR&D efforts, DOD provides feedback to contractors/Industry as it reviews IR&D activities; and, 3) DOD reviews the IR&D database, populated with Industry provided IR&D project descriptions, to identify IR&D efforts of interest.

Example: Inertial Measurement Units (IMUs). An Inertial Measurement Unit provides an output signal related to motion and acceleration to control and reporting systems. [DOD IR&D presentation used at DSMC, dated 02 Feb, 2002.] They are starting to be ubiquitous not only in large weapons systems (ships, aircraft, armor, UAVs, etc.), but also the weapons themselves as evidenced by JDAM employment during Operation Enduring Freedom. They are also making inroads into the commercial market for vehicle navigation assistance systems and GPS support. Thus the market for commercial and military use is present, though currently, primarily in the military area.

The IMU IR&D project cost was some $10 million, to support integration into more than 20 weapons systems. The marketing objective was to gain a greater than 10 fold increase in sales, and a unit price reduction of more than 2/3s. Currently, the product, the HG1700, has annual sales of approximately $100 million and is rising. It is integrated into many systems, including multiple rocket launch systems, Standard Missiles, F/A 18's, and JDAM / JSOW.

IR&D helps to nurture and maintain communications of needs and resources between DOD and Industry, to meet war fighter capabilities requirements, and supporting cost savings objectives. Thus, DOD can utilize the significant Industry investment in R&D to help maintain a technological edge over any adversary. Additionally, when considering new efforts, scientists and engineers can and should check and review the IR&D database for partnership possibilities through existing efforts, and thus be able to reduce or eliminate redundancy of efforts while taking advantage of Industry's investments.

Small Business Innovative Research (SBIR)

As organizational research and writings have shown [Peters, 1992] [Peters and Austin, 1985] [Peters and Waterman, 1982], smaller groups generally are more adaptive and responsive to challenges and opportunities, than large groups many times just because they are smaller and less bureaucratic in some ways, and many times more committed to the effort. Thus DOD's SBIR program works to harness the innovative and adaptive talents of our nation's small technology companies for U.S. military and national economic strength.

Of interest are the small technology company, early-stage R&D projects which have commercial potential in the private sector and/or military applications, while also serving a DOD need or requirement. These are the candidates for SBIR funding. With FY 2001 funding of over $500 million, and FY 2002 funding of ~$500 million, the DOD Program is a part of the larger Federal Agencies SBIR program (administered by 10 agencies) with funding of greater than $1 billion.

The DOD SBIR Program objectives are to stimulate technological innovation, strengthen the role and participation of small business (where most jobs are created) in federally funded research; and, encouraging commercialization of technology (where commercial marketplace and stakeholder pressures and interests can potentially lead to reduced costs and improved product performance to maintain or expand market share).

Projects are screened and reviewed for selection and continued participation through 3 phases of SBIR effort. Phase I is the 'feasibility study' effort which is funded at the $100,000 level and scheduled for a 6 month execution period. For Phase II, the projects continue (assuming successful screening) with the effort focused on prototype development over a two year execution period, with an award of up to $750,000. (These first two phases are federally funded.) In Phase III, the funding is from private sector and/or non-SBIR government sources (i.e., program manager offices); and, the SBIR projects continue development into a commercially marketable product for military use and/or commercial sales.

Example: The Acoustic Mouthpiece using Terfonal-D is a project of interest in the Naval community. [DOD OTT, 2000, p. 20 & 49] This project started Phase I in mid-1995 and Phase II in late 1996. It has resulted in a low voltage transducer embedded inside a scuba diver's mouth piece, which allows hearing by dental and bone conduction. It supports diver-to-diver and diver-to-surface communications without the addition of non-standard scuba gear such as a full-face mask or mouth mask. It improves safety and mission effectiveness for military personnel. Further, it is available through "Soniwave" dealers in the U.S. for commercial and recreational diving applications to improve dive buddy and dive supervisor communications and all aspects of commercial underwater work. Examples of commercial applications are diving salvage and recovery; underwater construction; underwater inspections; and diving class instructor-student communications.

A further benefit of this technology has been realized for the civilian firefighting and rescue community. The aural pick-up transducer has been incorporated into the fire safety helmet head band for bone conduction pick-up. This produces hands-free communication, interoperability, waterproofness, and increased voice clarity due to ambient noise rejection. This improves communications and assists in fire & rescue team coordination. While this effort was developed with civilian firefighter, it likewise has military firefighter, damage control team, and individual military member applications where improved communications characteristics are factors in mission success or warfighter capabilities employment (e.g., Special Operations Forces applications).

The SBIR program receives Congressional interest due to the approximately 3000 contracts awarded annually to small high technology firms and business around the country.

Manufacturing Technology (ManTech)

The DOD Manufacturing Technology (ManTech) Program has been in place many years, it should not be confused with the commercial engineering and consulting firm which utilizes the same / similar abbreviation for it company. ManTech has been working to develop new and improved manufacturing processes for more affordable production of DOD weapon systems and components. The ManTech program objective is to improve affordability of DOD systems by investing in new and improved manufacturing processes across the weapon system life cycle. Thus, as depicted in Figure 5, the program addresses process technology issues from the systems development phase through transition to production and into sustainment (even potentially into end-of-life disposal). The program targets its investment strategy at essential defense manufacturing needs that Industry would not otherwise pursue alone in a timely manner because of risks or market pressures.

ManTech Program attributes are to improve the cycle time and process capabilities associated with manufacturing, repair, and maintenance facilities (depots, logistics centers, and shipyards) for weapon systems and their components via: processing and fabrication activities to develop affordable processes for metals, composites, electronics, and energetics/munitions; the demonstration of key information technology to support weapon system development, production, and sustainment through efforts to accelerate implementation of world-class industrial practices, advanced design, and information systems; the adoption of commercial practices for military applications; and, in the acquisition area of sustainment, projects are coordinated for common DOD opportunities to increase the reliability and reduce the cost of repair processes for aging systems, thus addressing avenues for reducing Total Ownership Costs (TOC) during the increasingly common extended service lifetimes of many of the weapon systems.

Example: A project recognized for demonstrating these attributes is the Enhanced Manufacturing Processes for Body Armor Materials, which received the 2001 Defense Manufacturing Technology Achievement Award. [DOD OTT, 2002, p. 22]

This project upgraded the body armor for soldiers and marines to stop rifle or machine-gun fire from its previous 9mm handgun capabilities. The team for this project developed and implemented two highly effective, light weight ceramic armor materials – siliconized Silicon Carbide and Boron Carbide plates – which vastly enhance the Interceptor Body Armor capabilities. The new armor plates are 55% lighter than traditional body armor, and have a cost approximately 60% lower that the original high performance armor plates prior to the start of this project.

Due to the reduction of cost, it is anticipated that police departments across the U.S. will also adopt this product. Further, this project has demonstrated 'jointness' through its leveraging of contributions from Army and Marine program offices, and, from private Industry.

This project demonstrates the ManTech attributes mentioned previously, showing that the ManTech program is driven by defense needs for technologies and systems that provide a superiority edge to the warfighters. It demonstrates that DOD is involving the commercial industrial base as soon as possible, by either adopting its best practices or transferring results of military processes to the commercial arena.

While the body armor plates developed by this project are potentially of use to police departments and other security forces, the current direct impact is felt by our deployed forces through the more than 50K plates already delivered and fielded, with 140K more plates on contract for delivery. These plates are supporting our forces in Operation Enduring Freedom.

Defense Production Act (DPA) / Title III

50 U.S.C. App 2061 et seq, The Defense Production Act of 1950 (as amended), is the primary legislation in place to ensure that essential national defense industrial resources and critical technology items are available when needed. The Title III mission is to establish, modernize, or expand domestic production capability and capacity for technology items, components, and industrial resources that are essential for national defense and for which either no domestic capacity exists or it is insufficient to meet defense needs.

This mission is accomplished by a variety of DOD provided incentives to domestic Industry, aimed at reduced risk associated with establishing the needed capacity. The DOD / government incentives include loans and loan guarantees, the purchase of advanced manufacturing equipment for installation in Government or privately owned facilities, development of substitutes, purchases, and purchase commitments. (The last two, purchases and purchase commitments, are the most frequently employed Government incentives over the past 20 years.)

These incentives may include sharing the cost of capital investments with Industry; process improvements which assist Industry to be potentially more competitive; material and product qualification for use in weapon systems; and, purchase commitments and purchases. The purchases and purchase commitments guarantee a market for Industry which reduces the risk associated with establishing production capacity. Also, they assist companies secure loans from banks at better rates of interest. With respect to cash flow, Industry gains an improved cash flow basis, i.e. more stable and reliable, which supports improved internal business and financial planning and execution.

DPA / Title III is organized and executed as a DOD-wide program, generally focusing on material and components that can be used in a broad spectrum of defense systems. One of its key objectives is to accelerate the transition of technologies from the R&D arena to affordable production and insertion into defense systems. Thus DPA / Title III is unique among DOD programs because of its focus on the creation or expansion of domestic production capacity.

Example: The DPA / Title III project example is Power Semiconductor Switching Devices (PSSDs), which was initiated in August 1998. [DOD OTT, 2000, p. 32 & 34] Its total contract value is $11.5 million, of which $9.7 million is invested via Title III, with Industry (the contractor) investing the $1.8 million balance, demonstrating the sharing of costs to reduce risk.

PSSDs are used for a variety of power control, conversion, and conditioning applications and thus can almost be considered ubiquitous within the defense and commercial sectors. They are used as medium and high-power electrical switches replacing larger, heavier electro-mechanical switches for military and power handling capability with reduced acquisition and life-cycle costs (reduced TOC). The combined applications in avionics, missiles, command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems will result in dominant military power supply markets for PSSDs in the future.

These devices will be essential to future applications for aircraft, ships, and ground vehicles, as well as directed energy weapons and systems such as the Electro-Magnetic Aircraft Launch System (EMALS) under development for carrier applications. Further, they will directly support the future Naval vision of producing and ‘all electric ship’ along with the Army’s Objective Force and Future Combat System. (Note: PSSDs are likely to benefit from several other related DPA /Title III projects associated with semiconductor materials development and production (Silicon-on-Insulator (SOI) Wafers, Silicon Carbide (SiC), and High Purity Float Zone (HPFZ) Silicon) and microprocessor improvements for manufacturing, production, and performance.)

(Author’s note: While this effort is needed and the requirement continues to be valid, the delivery target has moved to the out years. The initial contract ha been terminated. The idea and intent to provide the capability remains valid, and the project is significant for showing the willingness to stop an effort or project which can not execute, and provides a great opportunity for learning to support all around improvements in the future.)

Ultimately, the PSSDs will not only support future applications in all Services, they offer the potential for retrofit applications into deployed systems during their operational life to reduce operations and maintenance costs. Thus PSSDs can support the reduction of TOC through potential cost avoidance via reduced maintenance man-hours costs. They will also allow reduced weight with higher power applications, thus improving system capabilities delivery to the war fighters and supporting their execution of assigned missions.

Commercial Operations and Support Savings Initiatives (COSSI)

Like the DUS&T Program, the Commercial Operations and Support Savings Initiative (COSSI) Program began at DARPA in 1997, and was originally part of the DUAP. Through Congressional direction (1998 Defense Authorization Act) in 1999, COSSI transitioned to Service implementation with administrative oversight provided by the Office of the Secretary of Defense (OSD). The majority of COSSI funding is appropriated directly to the Services who are responsible for execution of the program.

COSSI originated because of the major concern associated with the rising costs of operating and maintaining the aging equipment in the military inventory. Its purpose is to reduce DOD's operating and support (O&S) costs by developing, testing, and inserting commercial technologies into fielded military systems. With the increasing age of systems, some military specific components have become obsolete (and the process will continue), and hard to get at any price. Thus, using commercial items adapted to function in military items, can reduce maintenance costs, improve system performance, and allow leveraging of the commercial products economy of scale for production and development (saving DOD R&D funds as well). The COSSI program funds the non-recurring engineering, testing, and qualification needed to insert a commercial technology into a legacy system. Like several of the other programs mentioned, COSSI uses 'other transaction authority' to further assist in reducing the burdens of administering the project efforts, thus introducing improvements faster, at reduced costs, to the war fighters and their systems sooner, while reducing TOC for those systems and improving their performance.

Execution of COSSI is a two-stage process: Stage I – Development, modification, and testing (to be completed usually within 24 months); and, Stage II – Procurement of production quantities. During Stage I, proposals are submitted for consideration. The teams or firms must include at least one 'for-profit' member organization, and the proposal must be accompanied by a statement of support and commitment from the Military Customer with authority to modify the system and procure production quantities in Phase II. With proposal acceptance, modifications are made to the core commercial product for military application, it is tested and evaluated for satisfactory performance in the selected application and operation environment. If Stage I is successful, the project transitions to Phase II utilizing the military customer's procurement and installation funds for full implementation into the operating legacy system.

Example: The Health and Usage Monitoring Systems (HUMS) is used as a Helicopter Integrated Mechanical Diagnostic tool. [DOD OTT, 2001, p. 32] [NCAT, 2001, p. 47-49] The issue was the many diagnostics which were/are performed manually which are labor intensive, can be inexact, and thus lead to unnecessary maintenance actions of removing blades. These removals and reinstallations require many maintenance flights and other complex and expensive tests dedicated to main rotor track and balancing activities. The developed HUMS eliminated most of these flights. Further, it supports engine diagnostics, parameter exceedance monitoring, mechanical diagnostics, usage monitoring, etc. It is likewise used in commercial helicopters saving large amounts of maintenance funds, while supporting a higher aircraft availability rate.

While initiated with Navy SH-60 and CH-53 helicopters, the Army will apply it to versions of the UH-60 helicopter and the Marines in the AH-1Z and UH-Y helicopter remanufacture program. Thus it shows multi-service application and benefits, and demonstrates the wisdom of adapting civilian systems to support reduction in TOC. The Navy estimates for the project are: 50-75% reduction in vibration related maintenance actions; 10-25% reduction in emergency repairs; 10-15% reduction in scheduled maintenance; and, 50% reduction in Rotor Function Check flights. When projected beyond the initial helicopter versions mentioned above, the potential for TOC reductions is significant. Further, there is the possibility for applications to fixed wing aircraft and other gas turbine engine utilizations.

COSSI was endorsed by the Defense Science Board study 'Preserving a Healthy and Competitive Defense Industry'; it supports the partnering efforts between government and Industry for multiple stakeholders; and, to date has garnered in excess of $5 billion savings in O&S funding.

Technology Transfer (T2)

While technology transfer is the objective of the Office of Technology Transition, bringing all the programs together assists in ensuring cohesion and the potential synergy of implementation as evidenced / shown by the individual program overlaps in Figure 5. While the Military Departments are separate agencies for implementation, they are also encouraged to look at the integrated set of programs as parts of a whole, and they have started integrating and organizing them as key parts of their internal technology transition efforts.

This overarching DOD guidance allows for a decentralized, flexible approach, while also ensuring the full use of the results of the Nation's Federal investment in research and development. The overall program attributes are the multiple mechanisms for partnering; authorized relief on aspects of normal contracting rules; and, joint development for military and commercial application. The Technology Transfer mechanisms are important to the laboratories' strategic planning for personnel, as well as spin-off, spin-on, and dual use development of technologies. Some of the mechanisms are: Cooperative Research and Development Agreements (CRADAs), Patent License Agreements (PLAs), Facilities Use Agreements, Personnel Exchange Agreements, and Educational Partnership Agreements (EPAs). Through these mechanisms and the previously mentions 'other transaction authority', some of the traditional normal contracting rules do not apply, which can accelerate the introduction of technologically superior, affordable defense systems, while ensuring that technology developed for national security purposes is integrated into the private sector from the federal laboratory activities to enhance the national technology and industrial base as a National resource in support of the war fighter.

One of the mechanisms for transferring technology is the patenting and licensing process. When the Department patents innovations the opportunity exists to license that patent for use, providing better employment of the technologies and potentially generating royalty income. Currently, royalty income associated with patents are used to: 1) provide incentives – utilized for the share of the royalty to the inventors and/or cash awards to technical teams; and, 2) provide for further R&D consistent with the R&D mission of the laboratory. If the primary focus and measure of effectiveness for the area of technology transfer were the assessment of the patent program success through the transfer and licensing of intellectual property via royalties and patent fees, then some improvement is available when looking at the amounts of expenditures and royalties associated with the patent and royalty fees. However, as a Department, there is an upward trend in royalty income to the various activities. The true metric of success, though, is the use of technology in which Department/ Government research dollars have been invested. While patenting and licensing assists in the employment of developed technologies, the CRADA mechanism is the main form of agreement between federal laboratories and firms to conduct joint research. That CRADA's may be more beneficial to firms because of the mutual efforts of the participating organizations. [NSF(UofF et al), 2001]

Example: A Technology Transfer item of note for the Navy is the most recent project recognized via the Admiral Bowen Award for technology transfer due to its significant impact on the sailor and the Navy. A new gasket for watertight closures has been patented and introduced by the engineers at the Carderock Division of the Naval Sea Systems Command, Naval Surface Warfare Center. [DOD OTT, 2002, p. D-5]

The traditional gasket lacked resiliency and would quickly develop a permanent set or grove from being compressed against the knife edge sealing surface of the closure frame. It would dry out, harden, and crack with age, and compromise its intended performance to provide a watertight and airtight seal on virtually every manually operated structural door, hatch, and scuttle installed on Naval vessels. While the material was inexpensive, its replacement labor costs have been arduous and time consuming.

The newly developed, patented, and improved silicon rubber gasket design is suitable for use in all Navy standard, manually operated non-ballistic structural closures in watertight, airtight, and even firezone applications. Its unique feature is its configuration – a radius cutout in the back – which provides added resiliency and allows quick and easy installation in the 'C' shaped gasket channel of the closure. The new gasket has been adopted for use in the entire Navy Fleet, as well as the U.S. Coast Guard.

Its impacts are through labor savings (installation time reduced by 90%); increased service life due to new composition and shape; less component wear due to 40% reduction in force requirement for closure mechanism operations; increased ship / vessel survivability by reducing potential spread of fire and smoke; and, cost savings for fire zone boundaries of approximately $18 per linear foot. Over 1,000,000 feet of the new gasket has already been installed throughout the Fleet. Its overall development cost was approximately $18,000 (including testing), making it a truly amazing 'return on investment' for helping the sailor and the Navy – this impact practically speaks for itself.

Another Spiral View

Through these examples and the discussion of these programs an attempt has been made to shed light on the tools and opportunities available for assisting not only the PMO and team members, but also the aggregated extended team of individuals and groups which stand behind and support the warfighters and C-Cs in the execution of their assigned missions.

Quite literally "to ensure the warfighters today and tomorrow have superior and affordable technology to support their missions, and provide revolutionary war-winning capabilities." [DOD S&T, 2001] While, all the examples cited are not immediately on the frontline, many of them address the very critical support and logistics tasks which can be considered as distractions from the 'pointy-end-of-the-spear' efforts of the warfighter. When that warfighter has less to worry about because the tail that supports their operations is better, more responsive, delivers, and sustains more capability at reduced

TOC, then the warfighter can increase their focus on development of their skills via TTPs and doctrine to achieve employment outcomes, and thus become a more credible entity and National tool.

This then supports, as previously mentioned, the four defense goals of: a) Assuring allies and friends; b) Dissuading future military competition; c) Deterring threats and coercion against U.S. interests; and, d) If deterrence fails, decisively defeating any adversary [QDR, 2001, p. 11]. The C-Cs assigned missions and expected outcomes is another way of saying these defense goals. They are an overarching connector between these programs (discussed earlier), the OE environment for evaluation, and, the extended teams of Program Management Offices and agents.

SUMMARY & RECOMMENDATIONS

Through technology superiority for National Defense, these programs support not only the execution of systems acquisition at reduced cost, but the fulfillment of delivery of capabilities to the warfighters and C-Cs, and support national military objectives. At the same time there are ideas and lessons to be gained and shared as.

In the area of PMO, the Program Manger as a leader, orchestrates an extended group organization which must remain connected with and to the warfighting customer stakeholder, along with the production and support (internal and external) organizations stakeholders. This is the connection between the front and rear lines of the military family. The Program Manager must help, and lead, the organization to anticipate shifting needs and develop individuals that can accomplish tasks prior to *in extremis* conditions. The Program Manager assists in alignment of the extended organization objectives with the various customers' needs and requirements. It is through the exposure to, and education about, the available tools (e.g., OTT Programs) that the organizations as a whole demonstrate a willingness to adjust, improve, and change.

In the area recommendations for adjustments, changes, and improvements, there are opportunities for other improvements, such as:

-Encourage organization risk taking and learning, by rewarding learning from mistakes. Don't employ the stick all the time, use lots of carrots. Set up some short term task forces or skunkworks.

-Consider and move individuals around the organizations to flesh out their spectrum of experiences and competencies. Including moving so that potentially entrenched procedures and processes can be critically reviewed for removal because of 'no or limited' value addition to the process, and exposure for cross-pollination of ideas and methods. Is there a need for a 'Director of Revolution'? to shake things up from time to time?

-Support and use the community of technology transition programs and efforts to improve the delivery of capabilities to the warfighters and C-Cs at reduced cost, at faster rates, and with more improved capabilities. What metric of performance is used for participation in the collected programs mentioned within this paper? Is there a better one, which is more challenging and promotes learning tied to the operation of skunkworks?

-Have the warfighters provide a portion of the evaluation input on Program Managers and their organizations' performance on delivery of capabilities to the warfighters, based on contribution to the execution of the warfighting missions within the OE environment as a part of the organization's embodiment and compliance with the Government Performance and Results Act (GPRA).

These OTT programs collectively reduce and restructure risks, and leverage resources and ideas from multiple sources, all to deliver increased capabilities to our number one customer – the war fighters on the front line. In the vein of USD (AT&L) Aldridge's remarks on spiral development, these programs in some ways represent a set of interlocking segments of a spiral life cycle of continuous improvement of components and capabilities delivered to the warfighters and C-Cs.

More importantly, these programs are additional avenues and paths for development and introduction of new technologies, even if most of them are NOT directly identified within specific budget lines and program elements. (Note: Title III has a specific funding line originating from the Senate Banking, Housing, & Urban Affairs and House Financial Services Committees.) These programs are the door openers for getting to that point of finding and making contributions to the war fighters, while at the same time allowing our scientists and engineers to perform in their areas of expertise.

The employment of the programs like those that are collected within the OTT, the fielding of the program products to the users for accomplishment of their assigned missions, and the recommendations offered above, may assist in improving not only the warfighters capabilities, but also the larger support organization behind the warfighter. So that . . . if deterrence fails, the adversary in opposition will be decisively defeated by the complete organization from warfighter to Program Management team members, to scientists, engineers, and administrators developing, supporting, and maintaining the weapons systems and capabilities the warfighters bring to bear in execution of their assigned missions.

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