Defense Science Board
2006 Summer Study

on

21st Century Strategic Technology Vectors

Volume IV
Accelerating the Transition of Technologies into U.S. Capabilities

April 2007

Office of the Under Secretary of Defense
For Acquisition, Technology, and Logistics
Washington, D.C. 20301-3140

Volume I of the Defense Science Board 2006 Summer Study on 21st Century Strategic Technology Vectors represents the consensus view of the study's membership. This volume (IV) is the report of the Accelerating the Transition of Technologies into U.S. Capabilities panel of the summer study. Its findings and recommendations were used to create volume I and it provides additional detail. Findings and recommendations provided in this and the other panel reports (volumes II and III) do not necessarily represent the consensus view of the full summer study membership.

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Executive Summary

The Problem

"Technological superiority" is a basic U.S. defense strategy—the strategic differentiator. During the Cold War, the objective of the Department of Defense (DOD) was to stay ahead of the Soviet Union in advanced weapons—for example, U.S. fighter aircraft would be capable of outperforming those of the Soviet Union. Since the bureaucratic system in the former Soviet Union moved slowly, the long DOD development times of 10 to 20 years did not keep the United States from meeting that objective. However, transformational changes—including the agility of adversaries to rapidly acquire and use new systems, and the availability of advanced technology and weapons on the commercial and/or global market—make these long development cycles in the Department of Defense unacceptable.

On the supply side, new commercial technology often reaches the market in 18 months or less, is of equal or better performance then DOD's, and is available worldwide far faster than historic DOD acquisition cycles. At the same time, on the demand side, adversaries are no longer trying to match the United States plane for plane, ship for ship, or tank for tank. Instead they are using asymmetric approaches—often with "disruptive" (that is, nontraditional), low-cost, simple technologies—such as road-side bombs triggered with garage-door openers. In such an environment, the United States needs to be able to develop new counter-capabilities in literally weeks.

Additionally, in the area of major defense systems—such as missiles or secure communication systems—many nations with advanced military capability have been willing to sell their weapons worldwide, either directly or through third parties, to any buyer with money (or even through barter). Countries such as Russia, China, North Korea, and Iran fall into this category.

As a result of these evolving conditions, the United States can no longer assume that it will stay ahead of its adversaries by simply

spending more on research, development, and procurement. Changes in the acquisition process—and the accompanying budget, requirements, testing, and other related processes—are required in order to dramatically cut the time it takes to field new systems.

Background

This desire for shorter acquisition cycles is not new. In fact, for reasons of economic efficiency, and to enable products to reach the customer faster, it has long been the focus of commercial product competition. Thus, in the commercial market, cycle time reductions of well over 50 percent have been realized, as the data in this report will demonstrate.

These efficiency and effectiveness benefits have, of course, been well recognized as equally applicable to DOD acquisitions; and numerous studies have urged that weapons' acquisition cycles be cut significantly. For example, a 1994 Congressional report asked for "a 50 percent reduction in cycle time;" a 1996 White House report requested a "25 percent cycle time reduction for major defense acquisition programs by 2000" (from a then-historic average of 11 years); a 1997 high-level DOD council stated they wanted to "aim for a 50 percent reduction in acquisition cycle time" (implemented in DOD policy directives); the 2001 Quadrennial Defense Review and the 2004 National Military Strategy requested "rapid adjustment to changes in the environment;" and numerous prior Defense Science Board reports (such as, in 1990, 1996, and 2001) have all strongly urged "greatly reduced acquisition cycles."

But the empirical data (contained herein) show that as the complexity of weapons has greatly increased, and the focus of the acquisition system has continued to push the state-of-the-art to its extreme—emphasizing maximum performance at the expense of delivery time and cost—the actual schedules for most weapon systems have been increasing.

The greatest difference today, and the reason that "this time it will be different," is that the nation is in a long war and soldiers are being killed because it is taking too long to get new equipment to the field—as story of the up-armored High Mobility Multipurpose Wheeled Vehicle (HMMVV), for example, illustrates (see Chapter 1). It is this change in

"mission need" that will hopefully drive DOD to implement the recommendations of this study. The economic and effectiveness benefits that will come from the shorter cycles will simply be an added benefit.

Summary of Recommendations

Today, in response to urgent war fighter needs, the combatant commanders are sending in requests for new equipment that they need "yesterday." To satisfy this demand, a large number of *ad hoc* organizations (reporting to many different places) have been set up—whose total funding, in fiscal year 2006, reached nearly $3 billion. Yet, in many cases, these organizations have run into enormous bureaucratic hurdles. Statements such as "there is no official requirement for that," "it is not a program of record," or "there is no money budgeted for that," are being applied to these programs. Additionally, there is no institutional memory among these many, *ad hoc* groups, and, as a result, little transfer of knowledge and experience to other parts of the defense establishment. To meet this need:

***Recommendation #1*. The Secretary and Deputy Secretary of Defense create a single, new entity, the Rapid Fielding Organization (RFO), with a high-level mandate and full budget and program authority, to provide funding for rapid fielding, sustainment, and transition to the military services.**

- Needs come directly from fighting forces to the RFO director.
- The RFO will be based on Defense Advanced Research Projects Agency (DARPA)-like principles with direct authority from the Secretary and Deputy Secretary of Defense, through the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD [AT&L]).
- Establish defense budget funding ($3 billion per year), with discretionary funds in year of execution.
- Its mission is to provide operational capability to war fighters as soon as possible (some in months, most in <2 years).

- Funding for the RFO, and appropriate emphasis, will allow for initial training, support, and operation until the components can program for sustainment.
- The RFO will be initially formed from multiplicity of existing programs (such as the Defense Acquisition Challenge, Combating Terrorism Technology Task Force, advanced concept technology demonstrations, and joint concept technology demonstrations).
- The organization will have alliances with the military services, especially their rapid acquisition efforts.
- RFO programs will normally be executed through a relevant military service.

While the RFO will address the truly urgent war fighter needs, there is still an absolute need to change the more traditional DOD "acquisition" process. This requires changes in the "requirements" process, the science and technology process, the logistics process, and of course, the weapons acquisition process itself—all geared to faster fielding of higher performance systems (and at lower costs).

The critical first step is getting systems engineering (which includes systems analysis) into the front-end of the requirements process—so that trade-offs can be made between desired performance, schedule, and cost (for the initial version of the system). This input must be captured *before* the requirement is set in stone. Then, to assure that the program can effectively make it through its development on schedule (and within costs), there needs to be a mechanism for making these performance/ schedule/cost trade-offs as the development evolves—without going back through the full (and lengthy) requirements process.

To meet these needs, the Secretary and Deputy Secretary of Defense, working with USD (AT&L) and the Vice Chairman, Joint Chiefs of Staff (VCJCS), implement the following recommendations.

Recommendation #2. **Milestone Decision Authority assure that a rigorous systems engineering process underpins input to the requirements process.**

This process includes development planning that relates candidate technologies and systems development processes to defined war fighter needs and technology readiness. It replaces significant elements of the current Joint Capabilities Integration and Development System (JCIDS).

Recommendation #3. **Establish a process allowing program managers, during the program execution phase, to receive timely decisions on requirements relief without having to go back to the Joint Requirements Oversight Council—specifically, decisions from the USD (AT&L) and senior user leader (such as the VCJCS).**

The next most critical action is to *accelerate* the phase of a program from its formulation (known as "Milestone A") through its concept development and technology development—so that it is ready much earlier for the official start of its Systems Development and Demonstration phase (known as "Milestone B"). Note that a favorable decision at Milestone A does *not* mean that a new acquisition program has been initiated—that occurs at Milestone B. However, Milestone A is currently optional—and, therefore, hardly ever held. It is believed that holding Milestone A will force both the program and the science and technology (S&T) community to focus on early technology readiness (for the initial block of the system), and thus accelerate the time at which a program is ready for Milestone B. Therefore, to achieve this S&T acceleration:

Recommendation #4. **USD (AT&L) change policy directives to make Milestone A mandatory (to initiate program technology and concept development) and to**

- **plan multiple technology development demonstrations**
- **generate more options, with adequate funding, to provide alternative solution**
- **address affordability, producibility, and supportability**

- **create concurrent manufacturing, supportability, and interoperability plans and cost estimates**

In order to get military equipment into the field as fast as possible, it is necessary to compress the period from when a program is officially approved for acquisition (Milestone B) to the initial operational capability (IOC) in the field. It is desirable to compress this time to five years or less as compared to the current cycle which often is 10 to 15 years, or longer. To achieve this compression, it is necessary to move from the traditional, linear acquisition process to a true "spiral development" process—one in which only the first "block" (spiral) is clearly defined (in terms of performance, cost, and schedule), and where subsequent blocks are to be defined based upon user feedback, operational needs, and technology evolution.

Critical for the success of spiral development is ensure at block 1 that the technology to be integrated has matured to Technology Readiness Level 6, that manufacturing processes are at Manufacturing Readiness Level 6, and that the system is at an appropriate Integration Readiness Level. While this requirement may result in getting only an "80 percent solution" to the desired performance for the program, it will result in fielding the system much more rapidly (at about 30 percent lower cost, and with much lower risk). It is this *earlier fielding* of high performance equipment that will be so valuable to future operations. Finally, to assure that it is fully recognized that there will be subsequent blocks (spirals), and that this is *not* the last chance to get new technology into the product (and, thus, to follow the historic pattern of forcing technology into a product before it is ready), S&T and advanced development for future blocks must be pursued in *parallel* with the full development of block 1. To achieve these objectives:

Recommendation #5. **USD (AT&L) mandate the use of "spiral" (or block) development to field initial, militarily useful capability in 5 years or less, while continuing research and development for later blocks.**

"Spiral development" is radically different from the historic, linear DOD acquisition process. Specifically, it will require changes to the following:

- budget process (continuous research and development [R&D])
- requirements process ("desire" may be satisfied in block "n")
- acquisition process (strengthening Milestone A and B for each block)
- experimentation (to work out the bugs early)
- test and evaluation process (testing for "military utility" versus a specification)
- logistics process (using and incorporating multiple blocks/spirals)
- training process (using and incorporating multiple blocks/spirals)
- operational planning process (to maximize benefits of each block/spiral as it is fielded)
- assessment process (net technical assessments and risk assessments by block)
- user feedback (operational units' inputs on the utility of, and problems with, early blocks fed back into the design of later blocks)

In addition to more rapid acquisition, either through the RFO or a spiral development process, DOD also needs to place greater focus on the exploration and development of *disruptive technologies and capabilities*—technologies and capabilities that are "disruptive" in two ways. First, they are disruptive to DOD traditions in that they are counter-cultural—and, as a result, receive significant resistance (remotely piloted vehicles, ballistic missile defense, cruise missiles, sea-launched ballistic missiles, stealth, and the Global Positioning System (GPS), are examples). Second, they are disruptive because they are war fighting "game changers."

For success, these disruptive activities require strong, senior-level support until they have satisfactorily *demonstrated* their truly-significant war fighting advantage. Until then, disruptive activities are usually under-funded, considered low priority, and tend to be largely ignored in favor of more traditional advances. This area of disruptive technologies

and capabilities is, of course, the primary focus of DARPA—to which continued attention needs to be directed. However, the services and defense agencies should similarly be encouraged to pursue these game changers. To do so requires high-level support, so the responsible office (Director of Defense Research and Engineering [DDR&E]) should frequently keep the USD (AT&L) and the Secretary and Deputy Secretary of Defense appraised of such efforts. Most critical is that these "disruptive" activities receive adequate funding.

Therefore:

***Recommendation #6*. USD (AT&L) assure adequate R&D funding for disruptive technologies, products, and processes to provide adequate development incentives to overcome the expected institutional resistance. Specifically, there should be an additional $200 million per year for DDR&E to allocate to the services and defense agencies for this purpose.**

While these six recommendations will have a very significant impact on the desired acceleration of equipment to the field—and with lower risk and reduced costs—they are necessary, but not sufficient. They must be accompanied by actions across a set of cross-cutting enablers, specifically:

- human resources
- systems engineering/systems analysis
- budgets
- technology reach
- industrial base
- incentives

Attracting the right people to the acquisition workforce is critical if DOD is to be a smart buyer and an organization that, based on experienced judgments, can make the decisions required for shorter acquisition cycles. Today, unfortunately, there is no career development program for DOD civilians comparable to the excellent one for the military war fighters and such a program is also lacking for military acquisition personnel. Similarly, there are few resources available, in

terms of both dollars and time, for civilian personnel training (again, in contrast to the military war fighter program). Also, it is becoming widely recognized that the nation has a crisis developing in science, engineering, and math education. *The Defense Science Board urges DOD to support initiatives in this area.* In addition, there are individual skill areas on which the DOD should focus and acquire talent—specifically, systems analysts and systems engineers, biotechnologists, and social scientists. These skill areas will be critical for DOD in the 21st century.

Therefore:

***Recommendation #7*. The Deputy Secretary of Defense direct the Under Secretary of Defense for Personnel and Readiness—working closely with the USD (AT&L)—to establish and manage career development for the civilian and military acquisition and technical workforce, including two-way rotation between industry and government.**

Career development should include opportunities for graduate education at top ten universities as provided by industry for its employees, and competitive research programs to address acquisition issues with a portion of the funds set aside for DOD participation.

Additionally:

***Recommendation #8*. Expand the DDR&E's National Defense Education Program (currently $19 million), targeting needed system engineering, biotechnology, and social science majors.**

As the DOD moves increasingly to more complex systems, and particularly to "systems-of-systems," often extending across multiple services, there is a greater need to apply the broad skills of systems engineering (including systems analysis, system architecture, test and evaluation, "virtual engineering," and "virtual product development") to each program. These skills are needed when making the performance, costs, and schedule trade-offs that are so essential for effective, affordable systems—systems that are delivered on short schedules and within cost. Beside the need for the government to build up its skills in this area, there is a need to establish clear lines of responsibility, authority,

and accountability. Therefore, the panel recommends the USD (AT&L) direct that each government major acquisition program manager:

Recommendation #9. **Re-establish a program-level chief systems engineer as a subject matter and process expert, with responsibility for life cycle costs trade offs, systems design, system implementation, and systems-of-systems inter-operability, and reporting at a senior program level.**

- Assure clear lines of accountability from government to primes to sub-contractors.
- Use modeling and simulation to facilitate and accelerate system design (including system-of-systems aspects) and to create a close, positive, systems engineering relationship with users, testers, and maintainers—beginning prior to Milestone A.

Recommendation #10. **Establish system-of-systems accountability to assure cost-effective optimization at the systems-of-systems level, not the pieces.**

For each system-of-systems, assure a specific authority to manage cost-effective optimization and integration, as well as interfaces and schedules. This accountability needs to extend across services when the elements of the system-of-systems are outside of an individual service boundary.

Recommendation #11. **Use truly independent, experienced, professionally diverse, conflict-of-interest-free red teams to ensure quality and to reduce program risks (technology, costs, and schedule).**

The essential element to rapid acquisition of advanced weapons systems is having the money up-front to make the investments in S&T, prototypes, and field testing. Other critical elements are having the resources and flexibility to pursue multiple approaches and being able to shift resources as the program evolves. "Doing it right," up-front, has been proven to save huge sums of dollars and time later in program development. (The return on investment has been shown to more than warrant the added, early dollars.) At the macro level, this means

sustaining a high level of DOD S&T investments in order to stay ahead. Too often, for short-term needs, the DOD has cut such investments, thus "eating the seed corn." Therefore, the Secretary and Deputy Secretary of Defense:

Recommendation #12. **Sustain S&T funding at the fiscal year 2007 budget level, in order to enable future responses to adaptive adversaries and to maintain technological superiority.** (The DOD science and technology budget is currently projected to fall in the out-years by almost $1 billion.)

Particularly important is supporting basic research for the long-term. Over the past 40 years, the resources devoted to basic research have been cut in half, as a percent of DOD's S&T funding, from approximately 25 to 12 percent.

Then, to achieve the specific objectives of the rapid acquisition programs, the Secretary and Deputy Secretary:

Recommendation #13. **Establish funding in the DOD budget ($3 billion per year) for the new Rapid Fielding Organization, with discretionary funds in year of execution.**

Recommendation #14. **For all acquisition programs, require budgeting to realistic costs (such as estimates from the Office of the Secretary of Defense Cost Analysis Improvement Group) and restore the practice of budgeting management reserves, to handle uncertainties (minimizing program schedule impact) and to maintain a record of the accuracy of realistic cost estimates for use in future cost predictions.**

Recommendation #15. **Budget S&T funding throughout the future years defense plan for future spirals.**

As noted, in many areas of S&T the DOD no longer leads the world. Among G-8 nations alone, 50 percent of S&T investments are made outside of the United States, 36.5 percent by U.S. commercial firms, 7 percent by other U.S. government agencies, and only 6.5 percent by the DOD. What is needed is a "prospecting and

exploitation" focus within the DOD to capture the commercial and global technologies for the DOD.

In fact, today there are even unintended barriers created by legislation to prevent this desired use of non-DOD-developed technology. For example, the many specialized acquisition and cost-accounting regulations which discourage commercial firms from doing DOD business: the various "Buy American," "Berry Amendment," and other similar laws against the DOD buying off-shore; and the "export control" prohibitions on "dual-use" products being exported (that discourage global firms from developing defense-related products). In today's global economy, these barriers all need to be revised (with due consideration of potential vulnerabilities) in order for the DOD to remain the world's technological leader. Therefore, the Deputy Secretary of Defense should direct the USD (AT&L) to:

***Recommendation #16*. Establish and fund a DDR&E Center for the Application of Commercial and Foreign Technology.**

- Expand and create a searchable database containing the status of DOD-applicable commercial, foreign, and other agency technologies (the old Defense Technical Information Center 1498 database serves as a model).
- Expand use of "other transactions authority" and other means to enable commercial firms to undertake business with the DOD.
- Implement recommendations from the 1999 *Defense Science Board Report on Globalization and Security*, to reduce barriers to acquiring foreign technology (see Appendix F).

In addition, there is a need not only to track what potential enemies can get from commercial and global markets, but also to determine what potential uses and capabilities they could make of these technologies for military application. Therefore, the Deputy Secretary of Defense should direct the Under Secretary of Defense for Intelligence, and the USD (AT&L) to:

Recommendation #17. **Charge the intelligence community, combatant commanders, and DDR&E with identifying foreign science, technology, and capabilities.**

- The combatant commanders should provide DDR&E with information concerning the operational use of new enemy capabilities.
- The intelligence community should inform DDR&E about information it receives from technology prospecting (as observed by its sources).
- DDR&E should develop a means of assessing, summarizing, and disseminating the information it collects from the DOD S&T community regarding threats and capabilities that result from potential adversaries' use of commercial or foreign technologies

As important as all of these recommendations are (for changes on the government's side), there also needs to be change on the industrial side. As is well known, there has been enormous consolidation in the defense industry over the post-Cold War years, and (while this has probably been stopped at the prime contractor level, with seven large firms remaining) there continues to be increasing vertical integration. To assure that the government always gets the best-value solution for critical subsystems (and/or elements of the "system-of-systems") the USD (AT&L):

Recommendation #18. **Ensure full and open competition for second- and third-tier contractors to the primes, and for lead systems integrators (essentially, the government oversee the "make or buy" decision); ensure the availability of alternative potential sources.**

- The government should fund competitive, alternative sources of R&D (at the prime and lower-tiers).
- Alternative sources are needed to ensure continued innovation (in performance, cost, etc.) and as a competitive alternative if the prime or lower-tier incumbent does not perform or allows costs to rise (on either the current block or for the next spiral).

To encourage firms to perform more research on future defense technology, the DOD should invest in companies that are leaders in the development of innovative sources of next-generation systems or products. Such investments will focus the attention of industry on the importance of independent research and development (IR&D) and create incentives for longer term investment. For DOD to appreciate industry's investments for the longer term, it needs to return to the prior practice of separating IR&D from the short-term, proposal-oriented, bid and proposal funds. Both IR&D and bid and proposal funds would continue to be allowable costs, covered by overhead, but this separation would provide the visibility and incentive for defense firms to think more in terms of the long-term future. (Fortunately, this change does not require a legislative change—only a change in regulation). Therefore, the USD (AT&L) should:

***Recommendation #19*. Require separate reporting for IR&D and bid and proposal by updating Defense Federal Acquisition Regulations.**

- Set corporate average as 3 percent of sales, as a target.
- Use this information to help make funding decisions in new technology developments.

In summary, many of the current processes for technology transition to the field actually create disincentives to early fielding. For example, to get into the budget, the "need" has to be identified and funded inserted two years in advance. Or, to try to get new technology into a program, it is far easier to interrupt the slow and sequential acquisition process, than to wait for a possible future system (which may, or may not, come along).

All of the proposed recommendations are intended to create *incentives* for moving high-quality, high-performance weapon systems into the field faster, and at lower overall costs. Given the long war in which the nation is currently engaged, and the fact that U.S. military lives are at stake, these recommendations need to be implemented *immediately*. U.S. war fighters (and the U.S. taxpayer) deserve no less.

Figure 1 contains a pictorial summary of these overall recommendations.

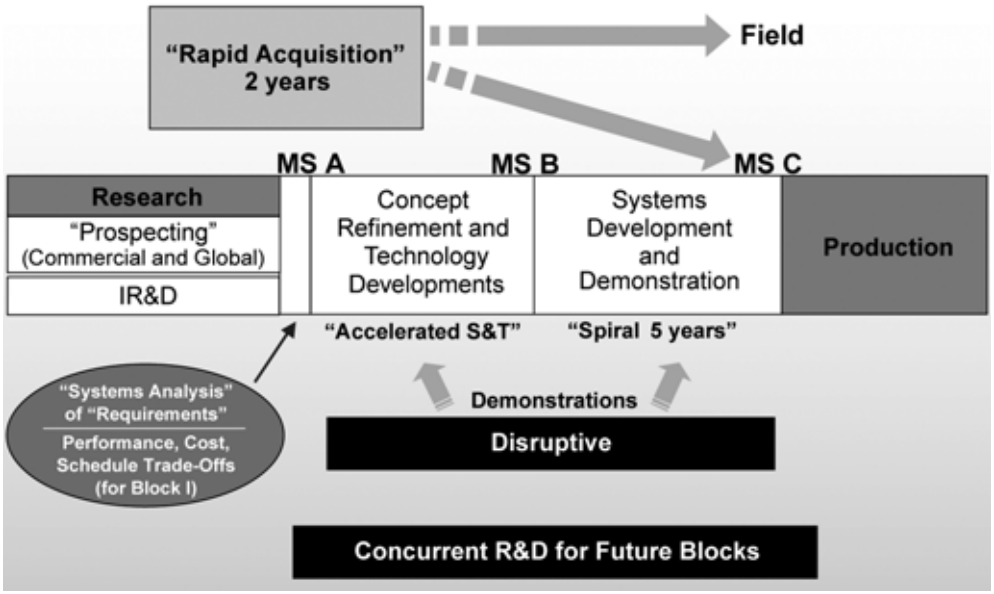

Figure 1. Time-Based Technology Fielding

Chapter 1. Introduction and Background

The need for shorter acquisition cycles has long been recognized and accepted. This is especially true in the current world environment in which the United States faces a range of potential adversaries, from nation states to non-state actors. For example, the Packard Commission,[1] concluded in 1986 that "an unreasonably long acquisition cycle—ten to fifteen years for our major weapon systems ... is a central problem from which most other acquisition problems stem:

- it leads to unnecessarily high cost of development...
- it leads to obsolete technology in our fielded equipment...
- and it aggravates the very gold plating that is one of its causes..."

In 1994, the Federal Acquisition Streamlining Act set the objective to "deliver emerging technology to troops in 50% less time." In 1997, Secretary of Defense William Perry stated: "...I am challenging each military department and defense agency to establish performance agreements that will reduce cycle time by least 50 percent by the year 2000."

Not only is there continued interest in reducing system development cycle times, but there is substantial evidence that such reductions are feasible. Table 1 shows cycle time reductions that had taken place in four different industries in the late 1990s and the goals for even further reductions.

1. The 1986 President's Blue Ribbon Commission on Defense was more commonly called the Packard Commission for its chairman, David Packard.

Table 1. Evidence that Cycle Time Reductions are Feasible

Industry	Past	Recent	Goal
Automobile	84 months	24 months	<18 months
Commercial Aircraft	8–10 years	5 years	2 ½ years
Commercial Spacecraft	8 years	18 months	12 months
Consumer Electronic	2 years	6 months	< 6 months

50%–70% Reductions in Cycle Time are Typical

Source: MIT Lean Aerospace Initiative

There are also examples, as shown in Figure 2, of development cycles that took too long and the associated systems that did not make it to the fight in time. The result was that systems that could have provided U.S. forces with a significantly increased capability were not fielded until one to two years after Operation Desert Storm.

A recent "horror story," of equipment that arrived too late to save soldiers, is the well-reported up-armoring of the High Mobility Multipurpose Wheeled Vehicle (HMMWV). As the story on page 6 shows, bureaucratic behavior resulted in slowing down the needed protection for soldiers, which needlessly arrived too late to save many lives.

Besides this obviously critical basis for a greatly accelerated acquisition process to meet field commanders' urgent requirements, there is also a need to get traditional military developments—such as missiles, radios, and aircraft—into the field much faster in order to meet the rapid changes in the technologies and capabilities used by adversaries. Further, in addition to this mission requirement, there is also documented evidence that longer development cycle times result in a greater likelihood of cost growth (Figure 3) and increased probability of program cancellation (Figure 4).

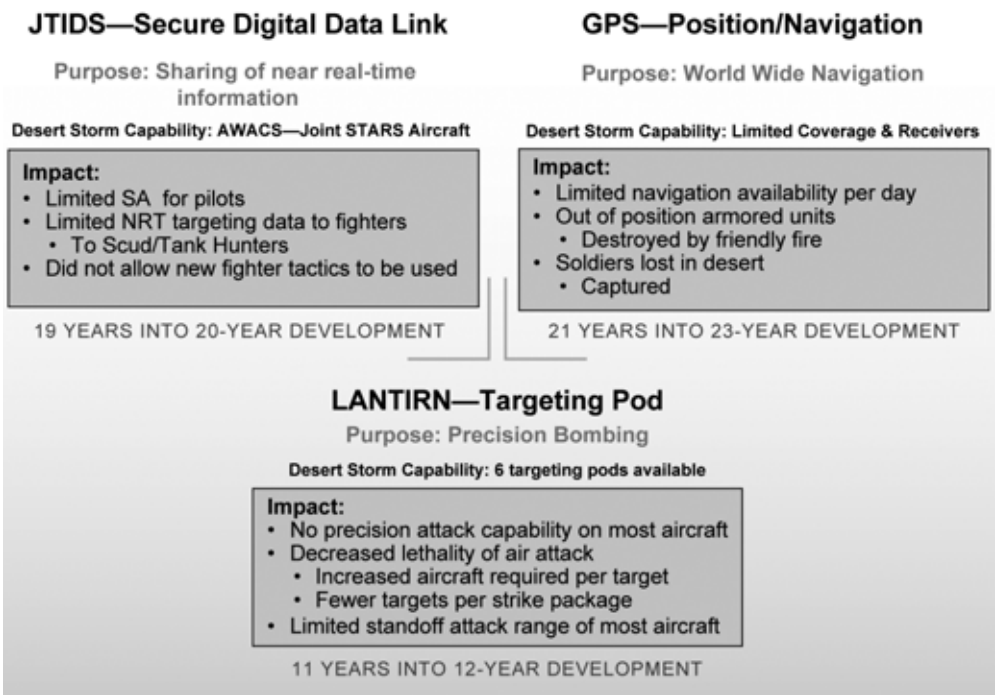

Figure 2. Capabilities Too Late for Desert Storm

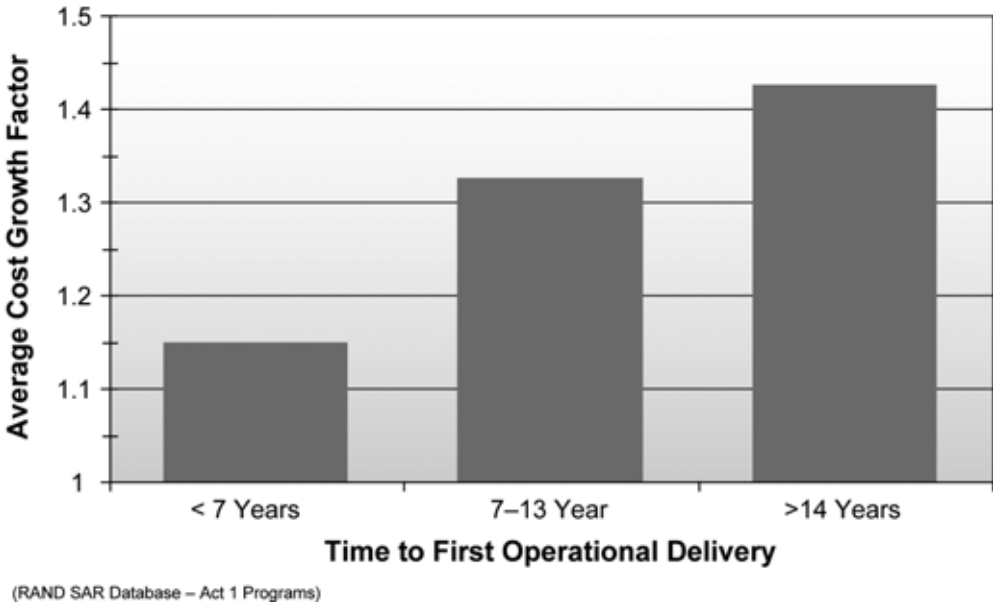

Figure 3. Likelihood of Cost Growth

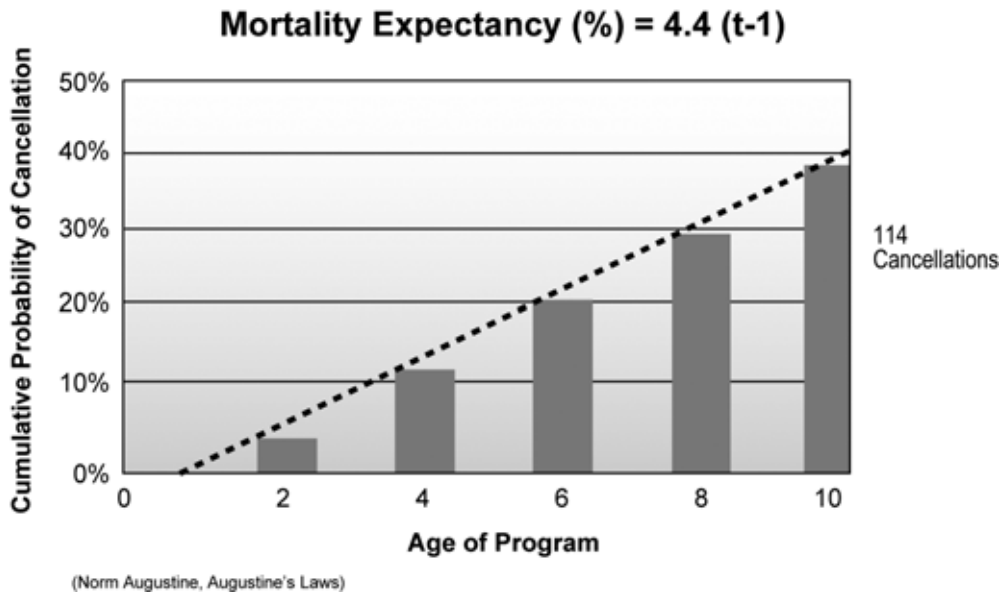

Figure 4. Increased Program Cancellations

Recognizing that there are a number of advantages to shorter acquisition cycles, as described above, there are also a number of impediments. To begin with, the requirements and acquisition processes are designed to meet mid- and long-term needs. There is a tendency in the initial requirements-setting process to overreach, in order to maximize the probability that a program will be approved. There is also a tendency for requirements "creep" to occur during program execution, often resulting from the development team's effort to meet operators' desires order to ensure continued support for the program into development. Funding perturbations, both from Congressional appropriations and from the DOD cutting healthy programs to fund overruns on others, also create turbulence and adversely affect program-development baseline schedules. Both expanded requirements and budget instability result in increased cycle times and cost.

Other impediments to rapid system development cycle times are bureaucracy and process substituting for executive leadership. Conflicting lines of authority, accountability, and responsibility for committed outcomes contribute to a lack of speed and agility in fielding capabilities with new technologies. Bureaucracy and inefficient

processes then replace executive leadership and speed in the decision-making process. When there is no single authority to say "yes" and many empowered to say "no," cycle times are not likely to be streamlined. What is needed is more effective and efficient collaboration among stakeholder communities representing the requirement and acquisition processes, Congress, and users.

Cultural impediments also tend to resist disruptive technologies in favor of near-term and familiar approaches. This delays the ability to rapidly field technologies that could represent "game changing" military capabilities. To successfully transition such technologies requires executive leadership and support; collaboration between developers and users; and a capable, experienced team accountable for the committed outcome of fielding the capability.

Looking to the future, there are further challenges to rapid transition of advanced technologies into fielded systems. Technical expertise has been declining in the DOD and, in some ways, in the defense industry. The ability of government and industry to execute complex system development programs will be challenged with marginal supply chains, quality of workforce issues, and S&T funding pressures, which are likely to increase in the absence of annual supplements to the defense budget.

Overall, new acquisition approaches, described in Chapters 2–4, are required. In addition, actions are required to improve DOD capabilities in a set of cross-cutting enablers, the subject of Chapter 5. The report concludes, in Chapter 6, with a summary of findings and recommendations.

The Up-Armored HMMVV Story

From its earliest stages, the ground forces in Iraq depended heavily on wheeled vehicles. Ground forces patrolled, transported, and re-supplied by HMMWV and various trucks. Few of these vehicles were inherently armor-protected, leaving the occupants vulnerable to ballistic weapons and the growing problem of improvised explosive devices (IEDs).

Beginning in June 2003, the Army recognized a surge of IED attacks. By August 2003, the commander of the 101st Airborne (Air Assault) Division had requested vehicle armor. Not waiting on the acquisition process, soldiers and Marines in the field took it upon themselves to up-armor their vehicles with whatever they could find in Iraq. Sheet metal doors replaced rubberized canvas; a weak improvement but an improvement none-the-less. Plywood boxes filled with sandbags were also prevalent. No solution could be found in theater for glass and windows, so they remained vulnerable. The Army logistics community established its own "Skunk Works," with the cooperation of a Navy welder and an in-theater contracting officer who bought ballistic steel from Turkey. The steel was shipped to Baghdad, where the welder formed it into protective boxes that provided protection for crews during convoys.

Units in the field continued to produce such solutions as they waited for the institutional portion of the Pentagon to resolve a problem they believed should have been predictable. The Army's Rapid Equipping Force (REF), with the support of the Army G-3 and Vice Chief of Staff, contracted for and produced four variants of kits to armor various configurations of HMMWVs following the 101st Commander's request. In six weeks vehicles were completed and began rapid testing, while the bulk of the small buy was sent into theater for soldier feedback and analysis. Formal testing at Aberdeen Proving Grounds showed various performance levels for the different configurations, with some better than others. But all were significantly better than no armor protection or many of the ad-hoc configurations developed in theater.

Within days of arriving in theater, a convoy of a particular configuration was hit by an IED attack. Testimony from the vehicle driver (in an email and digital pictures) showed that he likely would have been killed had he not had the protection. With only a few of the kits in theater, additional feedback came in from other vehicles hit in IED attacks. Much like the first, most feedback included comments from the soldiers involved in the attacks, and was accompanied by digital pictures. A truck configuration had soldiers in the rear when an IED hit. While the truck sustained damage, only one soldier was injured by a piece of shrapnel, because he was above the armor when the explosion occurred.

The Up-Armored HMMVV Story (continued)

The acquisition community of the Army initially responded to the request for armored HMMWVs with inaction. This they justified because there was "no requirement" (meaning a formal one, fully staffed and through the process). The program of record for up-armored HMMWVs was funded and in production, but was not intended to replace all systems in theater—only deliver the remaining ones slated to go to military police and explosive ordinance disposal teams. This amounted to a few hundred kits when the forces in theater were on a path to nearly 10,000 HMMWVs in general use. When the problem with attacks on HMMWVs was pointed out, the response, which ended up in Congressional testimony, was simply that combat patrolling was "not the HMMWV's purpose."

Senior Army leaders directed the acquisition community to implement solutions through a rapid process. In response, the acquisition community required that all efforts fall under them and the REF kits were prevented from going into even limited production in order to wait till other alternatives were examined and formally tested. This process began in October 2003 and extended testing lasted until January 2004. Once the REF kits were stopped, no additional kits were fielded to forces in the field, with soldiers again having to depend on their own ingenuity. In the meantime, soldiers continued to die at an increasing rate. (From October 2003, when IEDs were killing soldiers at a rate of 10 per month, they rose to a rate of 25 per month in May 2004—with approximately ten times that many injured soldiers.)

Testing showed that the kits developed by the REF performed well. In fact, the kit from one vender out-performed the standard up-armor kits being produced for the Army's acquisition team. That Army company subsequently purchased the company that had built the improved performance kit.

As part of the process to look at alternatives, the Army Material Command directed the laboratory command to develop options. A ballistic steel version was produced and tested as well. Part of the motivation for such a solution was to find one that could leverage the under-utilized Army (organic) Depots for production. While not as good as some of the alternatives tested, the armor survivability kits were an improvement from rubberized canvas.

Still, the process of testing and evaluating delayed the initiation of production of these kits until February 2004, six months after alternatives were available, and without any further appliqué of blast and ballistic protection to theater for HMMWVs; and 9 months from recognition of the impending need. Yet, Congress had recognized the need and allocated $429 million in December 2003, nearly two months earlier.

The Up-Armored HMMVV Story (continued)

Congress further recognized the need for all HMMWVs in theater to be fully up-armored and allocated an additional $618 million in March 2004. Army senior leaders then pressed the acquisition community for a significant increase in production of the standard up-armored HMMWVs on contract to meet all the needs in theater.

Production of up-armored HMMWVs finally began in May 2004 just shy of a year after recognition of a need. In many ways, this is cited as a success for rapid acquisition. However, reflection shows that soldiers continued to die, due to IEDs, for nearly a year; while the acquisition community carefully came to the conclusion that they should begin contracting for an already-proven system. They essentially transferred programmatic risk, for which they would have been responsible, to the soldier on the ground bearing it as an operational risk—which cost lives rather than management risk.

An alternative view might have been to see the need, begin meeting it with additions to the contract in place, buys of the REF kits, or both and optimize later. This alternative would have ensured rapid resolution to a higher degree than by the ad-hoc, in-theater systems—and in a timelier manner than even the "accelerated" acquisition thrust upon the community.

Resistance to such rapid acquisition continues, as the field encounters an evolving enemy. The insurgency in Iraq has not limited its IEDs to the original design and deployment. Because of this, IEDs have become more effective and the original up-armor, kitted HMMWVs have not provided the desired protection. Yet, that is the system continuing to be procured, essentially unchanged.

Alternatives have been fielded in-theater and proven effective through several of the rapid processes. The REF and the Joint Improvised Explosive Device Defeat Organization have both put South African Buffalos and Cougars in-theater to help protect some of those more likely to encounter IEDs. To date, no lives have been lost in numerous attacks on these vehicles. Still, they have not been adapted for general use. Recently, the Special Operations Command requested modified HMMWVs (by general purpose vehicles) with an alternative armor package that proved very successful in formal testing against IEDs. Despite this success, the acquisition system has not purchased any as alternatives to the current Ogara-Hess armor package, and backed off the Special Operations Command buy from the requested 80 vehicles to 30. Rapid acquisition, in this case, certainly was hindered by the response time of the major acquisition community.

Chapter 2. Rapid Fielding

The current threat environment of the global war on terrorism is characterized by elusive, fast-adapting adversaries capable of gaining temporary operational and tactical advantage by employing creative tactics and innovative technologies. Their successes often have far-reaching strategic implications. Against such threats, capabilities derived from traditional acquisition and development processes are inadequate. Adaptable adversaries capitalize on short commercial cycles to rapidly acquire and integrate capabilities from commercial and global arms markets into asymmetric capabilities faster than DOD can implement a countering capability.

In the current Iraqi conflict, for example, the Joint Improvised Explosive Device Defeat Organization estimates that the average time for insurgents to analyze and develop a countermeasure to coalition technology and non-technology capabilities, is two weeks or less. The adversary's development, acquisition, and delivery cycle is measured in days, while the time required for coalition war fighters to gain approval and acquire a capability to defeat them is currently measured in weeks, months, or even years. This asymmetry places a premium on anticipating threats and rapidly fielding capabilities to gain decisive technical and operational advantage. The DOD needs to better focus its efforts to provide innovative solutions that address urgent operational needs and customer requests to field capabilities faster.

Taken as a whole, the DOD can be described as a system based on communities. The communities involved in the delivery of capabilities include, but are not limited to, the requirements community, the resource community, the S&T community, the acquisition community, and the logistics community. Each community operates within its own processes and perceives its customers, outputs, and metrics differently. Specifically, the S&T community is funded to engage in worthwhile science and develop relevant technology. Once advanced technology is developed, the money and the accountability runs out.

The acquisition community, on the other hand, is charged with delivering programs of record that meet the needs of the requirements community within specific constraints of cost, schedule, and performance. There is little or no incentive to "harvest" what the S&T community has produced. It is much more common to depend on defense contractors to find and integrate technology into their products produced under contract. The department also faces the ever-present challenge of funding for execution and budget-year needs *inside* the normal decision timelines of the Planning, Programming, Budgeting, and Execution (PPBE) cycle. All of these factors argue persuasively for a more effective way to underwrite and execute programs to rapidly meet urgent operational needs.

Capabilities and Limitations of Current Rapid Acquisition Programs

The 2006 Quadrennial Defense Review (QDR) stresses the need to rapidly develop and field new, innovative, and transformational technologies and operational concepts. There are a significant number of programs currently operating that are designed to meet these challenges and are described, by the department, as falling into either of two categories: "rapid" or "agile." These programs are in contrast to the traditional acquisition processes covered by the DOD Instruction 5000 series framed by the PPBE process. Both "rapid" and "agile" programs involve projects that are purposely resourced inside the four-year, PPBE decision timeline. Such programs are defined as follows:

- **Rapid acquisition programs** focus on urgent operational needs with an emphasis on meeting initial materiel or logistics solutions in 120 days or less. They focus almost exclusively on procuring off-the-shelf technologies. It could be debated that these are, in reality, rapid "procurement" programs since materiel solutions are usually already known and all that is required is a procurement decision. The military services and the Joint Staff have a number of processes in place to address urgent operational needs requiring a procurement decision and are the departmental focal point for this requirement.

- **Agile acquisition programs** are often thought of as "applied technology" programs; they require little development or advancement of the state-of-the-art. The key challenge in agile acquisition programs is to integrate technologies, components, or subsystems to produce a new capability that can be demonstrated in months and fielded in three years or less.

The failure of the traditional acquisition process to respond to urgent operational needs has given rise to an increasing number of "rapid" initiatives or programs. Rapid acquisition is most often applied to programs focused on meeting very short- or near-term operational needs. To meet these needs, acquisition timelines are targeted in months, and most frequently in less than two years, but often extend to as many as four.

Current rapid acquisition programs primarily draw requirements from war fighting units. All programs share the common attribute that they respond to urgent operational needs, most often in the midst of combat or complex emergencies to prevent or minimize loss of life. The requirements that drive these current processes may be specific to a particular military service, or the area of responsibility where the capability is needed.

Most successful rapid acquisition programs were initially formed and implemented by small and dedicated groups of qualified, innovative people who accepted both the empowerment and accountability to accomplish the task. The extreme urgency of the situation attracted senior-level interest and support that, in turn, allowed the group to bypass, breach, or ignore bureaucratic obstacles as long as they remained legally correct.

Rapid acquisition groups execute their projects using a close relationship between the developer and end-user. Definition, development, testing, and refinement all occur in a continuous loop often on or adjacent to the battlefield or complex emergency site. They operate with little congressional or other oversight, and require small funding levels to execute, often never exceeding the range of tens to a few hundred million dollars.

The products from rapid acquisition programs tend to be simple purchases or integrations of existing technologies never intended to result from any significant technology development. They continue to be predominantly *integration* projects (as opposed to *development* projects) and almost exclusively use technology at Technical Readiness Level 6 or higher. The main challenge they face is the integration of technologies (components, software, subsystems) to produce new and improved capabilities.

Commanders who receive capabilities from rapid acquisition programs often use indemnification to relax original requirements when they exceed available technology. Solutions of 80 percent capability are accepted, while high levels of risk and occasional developmental failure are tolerated on the path to quickly reaching a useable solution.

The success of rapid acquisition programs has engendered a mindset oriented more toward developing innovative solutions and less compliant with the structured, "formulaic" approach that underlies the traditional acquisition approach. The sidebar that follows, on the first ground robots, is an illustrative example of a successful implementation resulting from these processes.

Limitations of Rapid Acquisition Programs

With the exception of large-scale initiatives such as robotics, most rapid reaction solutions are either left in-theater or not re-used by units in other missions. The effect is large numbers of solutions to common problems resulting in duplicative efforts and the need for significant "after the fact" integration.

Another significant point of failure for current rapid acquisition efforts are fiscal resources and overall governance; no joint lead is designated or empowered to budget for, oversee, or execute joint rapid acquisition programs. The Joint Requirements Oversight Council (JROC) has no funding authority to resource its directives, and DOD lacks any documents akin to the DOD 5000 series governing the traditional procurement process.

The First Ground Robots

During Operation Enduring Freedom, soldiers faced the dangerous task of clearing caves using grappling hooks, a technique unchanged since the Vietnam War. The only contribution from the traditional acquisition process was a "new" hook forged from titanium, to replace the iron one, and nylon rope. This advancement in grappling hook technology, procured by the conventional acquisition process, resulted from a two-year development effort.

Although lighter than its predecessor the new hook provided no increased safety to soldiers who used them to clear caves of booby traps. Any booby traps tripped by the grappling hook caused an explosion exposing the operator (hook thrower) to risk of injury or death. The significant amounts of unexploded munitions often hidden in the caves increased the potential that the initial detonation would ignite these stocks in secondary explosions of exponentially higher magnitude. A length of nylon was inadequate to provide sufficient protection in such circumstances.

Recognizing this continued risk to soldiers, the Vice Chief of Staff of the Army commissioned a small group to rapidly acquire and deploy robots as alternatives to grappling hooks for cave clearing. Initially resourced with less than $1 million, the program became the Rapid Integration of Robotic System (RIRS).

The inability to leverage resources and programs within the conventional acquisition required the RIRS to seek solutions from the private sector. The RIRS organic contracting capability allowed them to execute a sole-source contract within days, directing the contractor to leverage commercial-off-the-shelf items to resolve both the logistical and control issues. Within two weeks the rapid acquisition effort produced a wearable controller for testing, battery charge, and commercial power tools repackaged to support all possible variants.

The team deployed to Afghanistan with robots, developing the required draft operating tactics, techniques, and procedures (TTPs) on the commercial flight to theater. On arrival in-theater, team members employed the systems and revised the draft TTPs in combat along side combatant commander forces before handover to any units. Working closely with the user, including selecting and training soldiers who would become the actual operators, allowed the team to rapidly define the training protocols as well. As the new users were prepared to accept responsibility for aspects of the mission, the team withdrew, allowing transition of the robots to the unit in less than a month. A final briefing to the Army Vice Chief of Staff occurred within 90 days of project end and resulted in expansion of the effort to become the Army's Rapid Equipping Force.

Few rapid acquisition programs have any institutionalized funding source, and they place an increasing drain on programmed service budgets to survive. Almost by definition, these programs exist outside the PPBE cycle and can never meet its long lead-time forecasting cycles. While rapid acquisition programs, by their nature, operate in a domain where urgent needs are not known until just before or soon after they emerge, the traditional PPBE process only accepts known, documented, and validated requirements.

Over the years, allegiance to service goals were institutionalized and reinforced by a PPBE process that vested decision-making for force structure with the respective military services. The PPBE process leaves little room for exploitation of unanticipated technical discoveries or unanticipated urgent operational needs. As a result, virtually every rapid acquisition program is either unfunded or survives on supplemental funding to the defense budget. Even the JRAC takes funds from current service programs and appropriations or rely on supplemental funding. Department of Defense appropriations and processes are not designed to quickly deliver capabilities directly to the warfighter or through the combatant commanders. The process exits to support service development, fielding, and sustainment of their core capabilities. Even those programs that have the ability to fill the joint rapid acquisition gap using existing authorities lack statutory annual appropriations.

Even with adequate funding, most current rapid acquisition programs do little beyond purchase and delivery of equipment. Training support for rapidly generated solutions is minimal, normally confined to initial user familiarity with no follow-on or sustainment training. This situation is particularly problematic given the current operational tempo, where rotating units are arriving in-theater unable to fully make use of capabilities left by the preceding unit. In one recent example, equipment from a high-speed network portal was left in a closet and scavenged to network video games when the gaining unit lacked sufficient training to operate the equipment.

Although delivered faster and often focused on providing a specific solution, the capabilities resulting from rapid acquisition programs have an impact on doctrine, organizations, training, materiel, leader development, personnel, and facilities (DOTMLPF). When executed to

purchase small quantities used at the tactical level, the impact is minimal and often imperceptible. Conversely, programs that buy large quantities (robots and counter-IED capabilities, for example), even over time, have an enormous DOTMLPF impact.

Another significant roadblock to current rapid acquisition programs comes from attempts by the traditional acquisition community to provide oversight and to channel them into existing processes in an attempt to fill the need by merely executing the traditional process faster. The result is slowing "rapid acquisition" to "faster traditional acquisition" by burdening it with attempts to meet formal requirements and approval processes. Unfortunately, over time the attempted paradigm shift initiated by these rapid acquisition programs is paralyzed by the resurgence of traditional bureaucracy. Prudent oversight is subsumed by overly rigid control and by attempts to institutionalize rapid acquisition programs to make them fit within the existing JCIDS and equivalent service processes. The irony is the organizations that seek to subordinate rapid acquisition programs are the very ones that proved unable to meet the warfighter needs, necessitating the evolution of "rapid" capabilities.

Finally, any limited collection of lessons learned is kept within the unit or rapid acquisition element and rarely shared. The result is a continuous loop where other services and organizations are forced to "re-discover" solutions to common problems. These conditions will increase as the military services take on more non-traditional roles necessitated by limited DOD manpower and expanding missions of the global war on terrorism. For example, Navy personnel are increasingly involved in land-based security missions to relieve pressure on over-committed traditional Army and Marine Corps ground forces.

The lack of any ability to effectively capture and share lessons learned from prior experiences and technology breakthroughs is also having an adverse effect on traditional capabilities development. There is no better or more demanding laboratory than combat. What is learned there can inform requirements and capabilities development better than any prolonged academic study or voluminous requirements document. It can also provide valuable insights the DOD leadership can use to review current long-term programs and assess their viability and to inform

decisions on shifting available resources to more beneficial programs. This is currently not being accomplished with the *ad hoc* approaches.

These flaws in the traditional acquisition process lingered for years as continual irritants to combatant commanders and warfighters. The pressures of Operation Enduring Freedom and Operation Iraqi Freedom, as they continually ebb and flow between low- to mid-intensity conflicts and complex humanitarian emergencies, coupled with their evolution from expeditionary to long-term conflicts in the global war on terrorism, caused capability faults to burst. The current *ad hoc* collection of rapid acquisition programs remains incapable of sustained, timely, coordinated response to urgent operational needs. The system is in danger of complete collapse under the increasing weight of these *ad hoc* solutions and the increasingly large numbers of systems and products they generate with no planned sustainment.

Summary of Current Programs

The DOD programs currently in place that are concerned with the delivery of new or improved capabilities to the warfighter are varied. They range from service S&T programs dating back to the close of World War II, to the Joint Improvised Explosive Device Defeat Organization established in fiscal year 2006. Figure 5 depicts a sample of programs currently in place, or approved for fiscal year 2006, that focus primarily on "rapid" or "agile" delivery of capabilities to the war fighter. Funding profiles for these programs, an organization chart, and short description of each are included in Appendix E.

As Figure 5 illustrates, programs currently in place are aligned in such a way as to span the range of technology maturity while involving partners both within DOD and in the commercial sector. At the top of the chart, the various funding categories of research, development, test and evaluation appropriation; procurement; and operations and maintenance (O&M) indicate in general terms the type of funding allocated to these programs. The second line indicates Technology Readiness Levels (TRLs) and Manufacturing Readiness Levels (MRLs) that reflect the relative maturity of the technology and manufacturability. The third line indicates acquisition milestones (A, B, and C) that correspond with the approval

levels required in the DOD acquisition system. All of the category labels are approximate for illustration purposes.

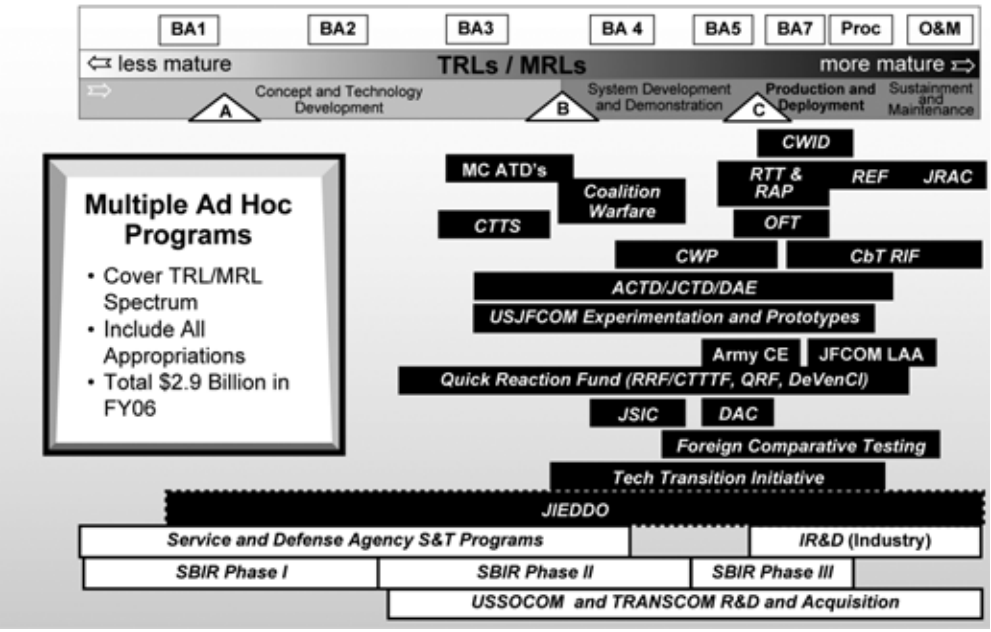

Figure 5. Example "Rapid" Acquisition Programs

It is apparent from the figure that DOD has attempted to cover the entire path of capability development from science and technology to initial procurement. Although these programs are making significant progress in fielding capabilities to the warfighter as quickly as possible, there are additional measures that would accelerate the process even more. Current PPBE processes discourage introduction of innovative capabilities lacking established community sponsorship. The lengthy process of programming and budgeting across appropriations prevents the initiation of urgently needed capabilities and the exploitation of perishable technical opportunities without "breaking" existing programs.

Another effect of the growing rift between current rapid acquisition programs and the overly restrictive legacy acquisition process is the inability of the current development programs to learn from warfighter experiences. While Operations Enduring Freedom and Iraqi Freedom continue to birth literally thousands of innovative solutions ranging

from robots to means to defeat IEDs, few, if any, successfully transition to existing or new programs of record. With no ability to capture, leverage, and learn from these experiences, DOD is forced to continually re-learn lessons at an increasing cost in terms of dollars and human lives.

Truly innovative military-industry joint ventures and other innovative solutions tend to become program orphans because parent service organizations do not exist to sustain them or they conflict with existing programs of record that the services and program managers feel obligated to defend.

Often, rapid acquisition programs slow to become merely "fast tracks" within traditional processes. The paradigm falters, new organizations emerge to meet the need, and the cycle repeats. In the process, truly innovative solutions are often lost or delayed, thereby putting the lives of soldiers, sailors, airman, and Marines at risk.

The story of door breaching and tactical awareness is another example of the barriers that stand in the way of rapidly fielding essential equipment to satisfy war fighter needs.

Door Breaching and Tactical Awareness

Martin Electronics, Inc. (MEI) is an ISO-9002 registered manufacturer of pyrotechnic and ordnance devices with over 30 years corporate experience. In January 2004 MEI's Director of Business Development was in Singapore discussing a new self-destruct 40mm fuse with industry partner Chartered Ammunition. The executive discovered two immediate warfighter needs in OIF and OEF were a true "door buster" round that would provide standoff for the warfighter and breach wood-paneled steel core doors, and a capability to improve the squad, platoon, and company-level commander's tactical awareness.

For door breaching, the standard low velocity 40mm ammunition (M433) has a tendency to only punch a small hole through the door without actually breaching it. This makes it necessary for soldiers to expose themselves both approaching the door and while breaching it with other means, putting them at risk.

Door Breaching and Tactical Awareness (continued)

There is currently no capability that enables tactical awareness below the battalion level, such as providing warfighters on the ground the capability to observe threats concealed on roof tops or behind buildings. Even at the battalion level it is virtually impossible to get an Unmanned Aerial Vehicle (UAV) tasked, as they are considered "national assets.

After returning to his corporate headquarters, the executive began exploring options to meet the perceived requirement. In early February 2004, MEI began researching camera companies. Within three weeks of that initial meeting First Witness sent MEI their initial camera design and the two held their first design review.

Concurrently with their development, MEI approached the Army Research, Development & Engineering Center (ARDEC) at Picatinny Arsenal, NJ, concerning the ongoing IR&D efforts on the product. In late March, Project Manager Maneuver Ammunition Systems (PM-MAS) visited MEI and was briefed on all their 40mm products. At the August PM MAS briefing the MAS staff suggested MEI and the ARDEC execute a Cooperative Research and Development Agreement (CRADA) to jointly complete the development of HUNTIR, MEI's breeching round (HELLHOUND), and another MEI developmental prototype round. MEI agreed and submitted a draft CRADA to the ARDEC CRADA office in September 2004, followed by an MEI briefing to the Program Manager Crew Served Weapons staff in December 2004. Both PMs requested expanding the CRADA to incorporate all 40mm ammunition enhancements. MEI submitted the revised draft CRADA on December 22, 2004.

In February 2005 MEI performed the first public demonstration of the HUNTIR round at Fort Benning, GA. The successful demonstration generated an enormous amount of interest from the Army Infantry Center. In March MEI requested an update from ARDEC concerning the CRADA and was told that ARDEC's Engineering Department declined to sign it because they believed they did not need external assistance to develop new ammunition types and saw no warfighter requirement for the capability.

To date, MEI and First Witness have completed Version 1 of the HUNTIR Round, successfully flying over 75 units. The round goes into first lot production by June 15, 2005 to fill order requests for test units from the U.S. Marine Corps, U.S. Navy SEALS, USSOCOM, Sweden, Denmark, and the UK. Total cycle time from capability identification to production line start-up was only 7 months. To date, ARDEC has failed to field either capability.

Creating a Rapid Fielding Organization

In order to satisfy the growing list of warfighter-required urgent needs over what is anticipated to be an extended period of "long war," the Department of Defense should create a new RFO, combining most of the current "rapid" and "agile" programs with some programs remaining within the services, but coordinated within the RFO. The RFO would provide institutional focus, with memory and knowledge-transfer, on achieving rapid response—weeks, months, or even a few years as compared to the longer, traditional acquisition process—and would be supported with adequate authority, budget, and incentives.

A distinction is made in this discussion between rapid "fielding" and rapid "procurement." Succinctly, rapid procurement has often been assumed to be synonymous with rapid purchasing. This entails the purchase of items and/or capabilities that are then provided to the user with minimum familiarization training and virtually no sustainment training. Conversely, the RFO would field systems and solutions with associated equipment, manning, and training.

A transformed joint force needs to be decisive across all domains and against all threats. DOD requires the capability to expeditiously develop, implement, and continually improve force capabilities (in terms of organizational design, process, capabilities, concepts, and human resources) in an increasingly chaotic world filled with asymmetric threats from highly adaptive adversaries. Consequently, DOD's response to these ever-evolving, highly dynamic threats has to be equally dynamic and more robust. DOD needs to be able to provide viable solutions to the warfighter within 24 months while, at the same time, leverage existing processes. This mission can best be accomplished by the creation of an RFO.

Construct of the RFO

The RFO will be established with a high-level mandate and full program and budget authority. Using direct authority from the Secretary of Defense, through the USD (AT&L), the RFO will rapidly

provide combatant commanders with capabilities necessary to conduct military operations. Given the time-sensitive nature of its mission, the RFO will be designed such that tasks can be quickly addressed and rapidly solved. As such, processes will be streamlined, and best practices from the private sector will be incorporated.

Perhaps most importantly, the RFO will be extricated from the complex bureaucracy that encumbers today's traditional acquisition process, including the voluminous requirements and extended lead times for study, review, and approval. Even though, technically, it will be a "bureaucratic" organization, the RFO will be non-conformist in its mode of operation, being more akin to a private-sector firm that is focused on delivering innovative, reliable, and cost-effective solutions rapidly to its customers. It will also be like DARPA in its independent focus on the mission. The RFO will focus on the combatant commanders as its well-defined customer base. It will prevent "mission creep" and will not duplicate capabilities currently under development elsewhere in the DOD.

The people required for such an elite organization should be hand-picked from among the best in government, the services, the private sector, and academia. Special emphasis will be placed on the leadership and the leadership team. Assignment to the RFO will be by personal selection. Experimental Personnel Authority will allow the RFO to hire expert program managers from industry at competitive salaries and faster-than-normal civil service rules. This structure will ensure only the most qualified, innovative, and customer-focused individuals staff and operate the RFO.

Capabilities of the RFO

The RFO will establish authoritative governance and management structures to expeditiously execute capability development and delivery. The solution will establish, reinforce, and maintain the practice of continuous involvement of the warfighter and developer. This approach will help to ensure the rapid fielding of interoperable and enabling solutions.

The RFO will provide solutions to urgent operational requirements across the force. It will pursue rapid prototyping of capabilities to ensure they meet urgent, unanticipated, warfighting needs and are conceived, developed, and delivered in an expeditious manner. The RFO while enable longer-term development by handing capabilities off to an appropriate service or agency when they can be included in a program of record, and supported by new doctrine and organization as required. Succinctly, the types of problems addressed by the RFO are normally those that can be resolved by capability improvements across the DOTMLPF to include information technology.

It is essential that the RFO not only provide equipment rapidly to the current warfighters, but also supply training and operational concepts to current warfighters and supply equipment, training, and operational concepts to those troops currently undergoing preparation and training to go into the field. This concept is shown in Figure 6.

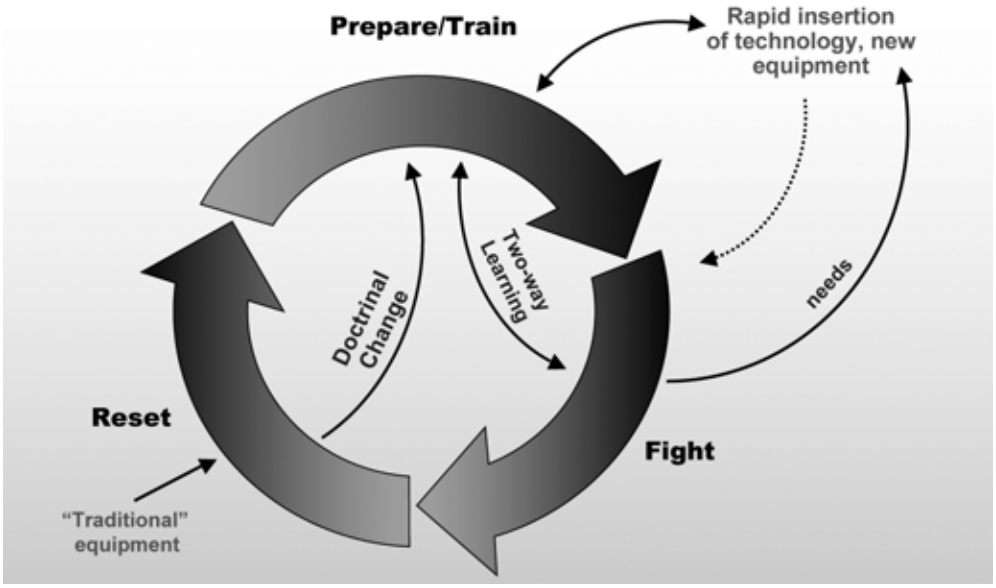

Figure 6. Inserting New Capabilities

RFO Processes and Operations

The RFO will execute using a unique operational construct that fills the critical gap between DARPA's disruptive innovation mission and the core-capability focus of service rapid acquisition programs. In so doing, the RFO will operate as an enabler, drawing off non-core mission functions from both, thereby allowing them to focus more on their specific missions. DARPA, for example, will be able to focus on its disruptive mission and away from programs focused on near-term solutions to immediate problems. The RFO will assist in coordinating memoranda of agreement with the military services for successful transition of DARPA and RFO products.

The RFO processes will be driven by clear, concise, plain-language requirement statements from the combatant commanders that receive quick action. Urgent operational needs will flow directly from the combatant commanders to the RFO Director who has complete approval and execution authority from the Secretary of Defense, as well as all required acquisition authority from USD (AT&L). The RFO Director considers requests or proposals that come from or are validated by a combatant commander or service. In the latter case, if the desired capability is for a specific combatant commander area of operations, that commander will validate it as an urgent operational need.

Once a request or proposal arrives at the RFO, the staff conducts a feasibility assessment to determine if the requested capability can be readily attained or if the RFO has a reasonable expectation it can be developed in 24 months or less. This assessment also includes a technical assessment, a cost-value analysis, determination of any parallel or competing initiative that could better meet the need, an assessment of material and non-material approaches to provide the capability, and type of evaluation required as well as the evaluation's initial criteria. The request is also assessed against a continually updated list of high-priority needs derived from the combatant commanders integrated priority lists and other input. Where prioritization of requested projects and proposals is required, the RFO Director relies on this guidance, seeking clarification only when required.

Following legal review by the RFO's organic General Counsel, the RFO Director either approves or disapproves the project or proposal and informs the requestor, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff of the decision, as appropriate. *The review and approval process will not exceed two (2) weeks.*

Project funding is drawn from the RFO's annual appropriated budget. This includes development, deployment, associated training, and sustainment until the relevant service either programs long-term support, the capability transitions to a program of record, or is divested. To ensure capabilities are developed and deployed with appropriate training and sustainment within its charter, the RFO will use the full range of appropriations. A portion of these funds is discretionary to the RFO Director; Congressional notification occurs at the start of each fiscal year with revisions by exception. To prevent the RFO from becoming burdened with long-term sustainment, sustainment packages will normally not be funded for a period exceeding two years without approval by the RFO Director.

Project execution begins when funds are transferred to a relevant service for contracting and implementation or, occasionally, when the RFO Director designates an internal team to deliver the capability. New contracts and modifications to existing contracts will be enabled by the RFO's "other transactions authority."

For all RFO projects, the capability is developed and/or acquired in close coordination with the user. This will often require in-theater development and testing.

The RFO's oversight, accountability, and sustainment responsibility for individual projects will normally end two years after delivery (when the program is fully transferred to the relevant service) unless specifically approved by the RFO Director. Throughout program execution, rigorous analysis is conducted of the process itself and of the products to fuel continual improvement of both, producing lessons for incorporation into later programs.

Accountability and Measurement Metrics

Success for the RFO will be measured both quantitatively and qualitatively. Initially, success will be measured by the following:

- the number of urgent need requests that have been successfully met
- the time required to satisfy those needs
- the number of capabilities developed that transitioned to service programs of record
- the number of innovative public and private sector participants engaged by the RFO

Most importantly, perhaps, success will also be measured by the number of unproductive, duplicative, or unnecessary programs identified, consolidated, or divested. This metric includes the potential consolidation of redundant acquisition programs.

The RFO will function using a hybrid model of authorities tailored to its unique mission as follows:

- The RFO will be authorized to enter into and administer contracts, grants, and cooperative agreements, directly or through a military department, in pursuit of its rapid-fielding mission.
- "Other transactions authority" will allow the RFO more flexible contracting arrangements than possible under the Federal Acquisition Regulations.

A proposed draft charter for the RFO is contained in Appendix D.

Implementation Recommendations

The RFO will be designed to compliment and oversee service and joint rapid acquisition efforts. The RFO mission as a fielding organization, not only a procurement entity, ensures it will provide total support by working with the military services to ensure capabilities are provided with the appropriate training (user, replacement, sustainment), organizational support, and testing. The RFO's close relationship with

its customers will enable it to fill combatant commander urgent operational needs in response to requests flowing directly for fighting forces to the director. Prototype development, evaluation, and refinement conducted with users in the field will enhance this relationship. The RFO can also provide lessons learned and other program support, reducing duplication of effort.

Implementing the RFO is possible almost immediately, but establishing the RFO will require a strong Secretary of Defense charter, supported by USD (AT&L) on behalf of the acquisition community. It requires a designated and empowered joint warfighter advocate, such as the Vice Chairman of the Joint Chiefs of Staff, who will represent the combatant commanders, and with strong private sector support. It is impossible to implement the revolutionary, innovative approach the RFO represents using legacy DOD management approaches.

The RFO organizational design and business processes need to be as transformative as its vision. As a model, a private enterprise is a ubiquitous system; a goal-directed and focused organization of various activities, processes, and resources, usually of significant complexity in strategic and operational scope and risk. It is a model worthy of emulation. Such models need to continually deliver innovative, reliable, cost-effective technologies and/or solutions to a very competitive marketplace, and in a timely manner. The speed with which this is accomplished can be directly correlated to success. Consequently, this delivery-oriented mode of operation creates a need for strategic simplicity. It also requires that the firm's executive leadership not only communicate its strategy in an effective manner, but also mandate measurement metrics that focus product development on the achievement of lower development costs, and increased revenue, market share, and profitability.

Among others, what this type of environment creates is incentives to maintain an efficient technology development process that is constantly focused on and adaptive to changing market conditions, and the needs of its current (and prospective) customer base. Further, companies that compete in the technology domain realize that ultimate success cannot be achieved until new, innovative, and refined technologies and/or solutions are successfully transitioned.

At the core of the RFO are the interactions and dependencies between its stated goals and the processes that are established and implemented in order to achieve those objectives. Consequently, it will be incumbent upon the leadership team to not only determine but also align the incentives of those in its value chain. Table 3 contains some suggested processes that should be adopted by the RFO's director. These processes both determine and govern the means to achieve stated enterprise goals and objectives, embodied in the operations of the enterprise.

To begin implementation, the Secretary of Defense direct the USD (AT&L) and other appropriate agencies to provide a structure and implementation plan. This plan can be developed in 90 days with support from the Defense Science Board (DSB) and other private sector entities. It is critical this group include innovative and non-traditional industry advisors that will bring the entrepreneurial culture critical to the RFO's success.

Table 3. Processes of Successful Private Enterprises

Process	Process Attribute(s)
Situation assessment	The executive team gathers data and information from multiple sources to acquire a holistic perspective of the enterprise and the world. Its strategic view is derived, in large part, from drivers external to the RFO.
Vision and strategy development	The executive team sets and/or refines the vision of the enterprise and develops the overall direction and strategy.
Strategic decision-making	The executive team makes decisions that affect the direction of the enterprise, not tactical, day-to-day operational decisions.
Communication of intent	The executive team develops a framework that can be used to communicate both strategic and tactical information to its stakeholders.
Recruiting and retention	The executive team recruits and retains key managers and employees necessary to accomplish stated business goals and objectives.
Designing incentives and rewards	The process of offering incentives and rewards to executives and employees for achieving key business goals and objectives.

The groups' task will be to develop the organizational design, business process, capabilities, concepts, human resources, and other business processes required for the RFO and identify changes to existing DOD to:

- Create an environment of continuous involvement with the warfighter for a full and open dialogue (vice discussion) of capability requirements so developers can quickly determine them.[2]
- Increase the interaction between warfighters and capability builders to increase the speed at which proposed solutions are operationally assessed and improved.
- Increase the speed of fielding capabilities through streamlined business practices that enable timely delivery of integrated capabilities.
- Establish an authoritative governance and management structure that will allow the RFO to consolidate all rapid acquisition programs.
- Reduce the process impediments to rapid solution development and fielding.
- Reduce the cost of development by using warfighter input to more quickly identify and terminate inadequate solutions.

In his role as the defense acquisition executive, the USD (AT&L) has the authority required to empower the RFO. USD (AT&L) can use its title 10 authority to establish policies for acquisition (including

2. The term dialogue is specifically chosen to set the tone and the environment for the effort. By definition, dialogue means "flow of meaning" while discussion has the same root as concussion and percussion—literally "to shake apart" or argue the pros and cons. Dialogue is "inquiry-oriented or listening-oriented" while discussion is "advocacy-oriented." This behavior is key to the organization's approach of free and open discussion where participants shed their parochial baggage in favor of contributing toward the best solution regardless of source.

procurement, R&D, logistics, developmental testing, and contract administration) required by the RFO.

Initial RFO funding will be drawn from existing rapid acquisition programs and supplements to the defense budget, while legislation for full funding is developed for its estimated $3 billion annual budget. It is critical the appropriations action begin immediately, or the initiative will be pushed to the next legislative cycle where it will run the risk of being ignored or forgotten.

DOD has a window of opportunity to take small steps that can be easily implemented and that will immediately provide some of the core capabilities the RFO requires. These initial steps will establish a firm foundation for the RFO and implement a model for real-time assessment of proposed RFO attributes while the full capability evolves. Most importantly, these initial actions will have an immediate, positive impact on the warfighter.

The warfighter needs the RFO now. The ability to define and implement it is now. DOD need only seize this opportunity. Its payoff can be immediate. To see this, consider the World War II example in the sidebar below.

The Rhinoceros: A World War II Innovation

A well-known example of American wartime innovation is the development and application of the "Rhinoceros" or "Rhino" hedgerow buster. This was typical of the process of decentralized adaptation that made the American Army in Europe so successful in World War II. The brainstorm of Sergeant Curtis G. Culin, Jr., of the 102d Cavalry Reconnaissance Squadron in July 1944, the device consisted of prongs fashioned from a German roadblock that allowed a Sherman tank to force its way through a hedgerow without having to expose its vulnerable underbelly. Fifth Corps commander Major General Leonard Gerow recognized the Rhino's significant potential, and he invited General Omar Bradley to view a demonstration. The First Army commander was so impressed that he instructed his ordnance chief to comb England for arc welding equipment and to mass-produce the devices from beach obstacles. By the time of the great Operation Cobra attack in late July, 60 percent of American tanks were equipped with Rhinos. To ensure surprise, none of those Shermans were allowed to go into action before Cobra. Once the attack began, German armor was restricted to the roads, while the Americans flanked them through the hedgerows. ***The tactical and psychological impact of Sergeant Culin's innovation, exploited by Omar Bradley, was a major factor in the breakout from Normandy."***

Source: Crane, Conrad C. "Beware of Boldness." *Parameters.* Summer 2006, pp. 88–97.

Chapter 3. Traditional Acquisition

The Requirements Process

At least two recent DSB studies have pointed out deficiencies in the "requirements process" as it affects efficient and effective development of military systems.[3]

The process of setting initial requirements lacks a rigorous systems engineering process to address warfighting needs in light of the programmatic challenges relating overall system development cost, schedule, performance, and risk. A more rigorous approach would set requirements based on warfighter needs and systems analyses that included assessments of advanced technology impact on a system's ability to meet those needs. The systems analysis would optimize cost, performance, risk, and schedule, within a defined trade space, using modeling, simulation, technology demonstrations, and prototyping, as appropriate. This approach is shown pictorially in Figure 7.

The results of this more rigorous approach would be used in defining key performance parameters (KPPs). In spiral development of a system, the process would be used to define the KPPs for spiral 1.

Recommendation

Milestone Decision Authority assure that a rigorous systems engineering process underpins input to the requirements process. This process, which replaces many aspects of the current JCIDS process, includes development planning that relates candidate technologies and systems development processes to defined warfighter needs.

3. *Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on the Acquisition of National Security Space Programs*, OUSD (AT&L), Tom Young, Chairman, May 2003; *The Defense Science Board Summer Study on Transformation: A Progress Assessment*, OUSD (AT&L), Dr. Robert Hermann and GEN Larry Welch, Chairmen, February 2006).

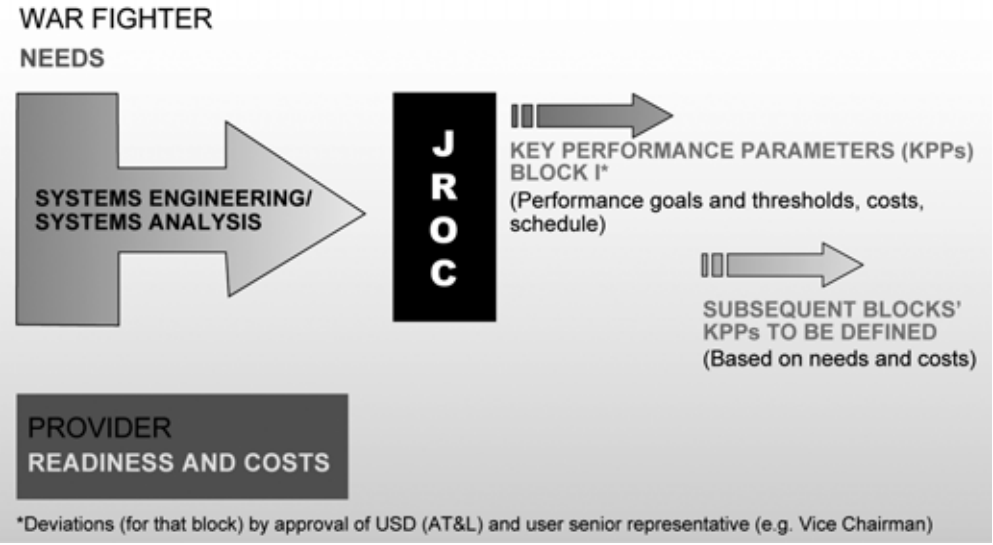

Figure 7. Getting Systems Engineering in Early

Force providers should assure rigorous systems readiness assessments are completed prior to finalizing requirements. This includes TRL, MRL, and integration readiness level (IRL) assessments, as well as assessments of system affordability, risk, and schedule.

There also exists a deficiency in the way requirements are managed *during the program execution phase*. In the development of military systems, unforeseen problems can arise that lead to cost and schedule overruns. A process is lacking to provide program managers with timely decisions on their proposed trade-offs of top-level requirements, including KPPs, to achieve cost and schedule commitments. Hence, there is a tendency to strive to meet KPPs at the expense of cost and schedule, leading to overruns and delays in fielding. Program managers should be able to suggest (to a designated requirements authority) trade-offs that allow more efficient program execution. For example, perhaps the 80 percent solution two years earlier and a few billions of dollars less expensive would provide a superior military benefit than the baseline system that meets all requirements but is years later to the field. In a spiral development approach, some requirements could be deferred to a future block.

Recommendation

Establish a process allowing program managers, during the program execution phase, to receive timely decisions on requirements relief without having to go back to the JROC— specifically, by decisions from the USD (AT&L) and the Chairman or Vice Chairman, Joint Chiefs of Staff.

Finally, programs should not accept a new requirement unless it: (1) has been assessed by the business and systems engineering process to define cost, schedule, and risk consequences, and any unintended consequences; (2) has been approved by the senior designated requirements authority; and (3) comes with the budget to cover cost of the new requirement.

Accelerated S&T Developments

The DOD acquisition process is currently almost exclusively focused on readiness plans at Milestone B, followed by continued attention on post-Milestone B processes and plans. The Government Accountability Office (GAO) has shown that commercial businesses focus on reducing risk prior to entering "product development" (Milestone B equivalent). To accomplish this focus on early risk reduction, commercial businesses establish a gated process that does not allow products to move beyond "technology development" *until* the critical technologies achieve a sufficient level of maturity (Technology Readiness Level 6 or better). Also shown by the GAO (and discussed in the next section), many DOD systems (platforms, weapons, networks, systems-of-systems) start Milestone B with immature technologies (a TRL of less than 6). These programs offer some form of risk mitigation intended to enhance performance to TRL 6 after Milestone B, but the result is large schedule slips and significant cost overruns.

DOD's attention is not adequately focused on the technology development phase (from Milestone A to Milestone B). This lack of attention forgoes the opportunity to provide early risk reduction or to accelerate technology development and meet warfighter needs sooner. DOD is not following the principles described in the Defense Acquisition Guidebook: "…the S&T Program is uniquely positioned to

reduce the risk of promising technologies before they are assumed in the acquisition process."

Findings

Most DOD systems that start with immature technologies have the following results:

- The system is late and costs grow.
- The technology obsolesces as the program is stretched.
- When fielding occurs, fewer systems are purchased.

There are a number of lessons from these circumstances. Often, technology in an immature state has been forced into programs because it is believed to be the only opportunity for a new technology to move forward. This behavior is an unintended consequence of resource competition between often dissimilar programs.

Congress demonstrated its concerns about cost and schedule growth in DOD's programs through the 2006 Defense Authorization Act, Section 801. This act requires the USD (AT&L) to certify, prior to Milestone B, the needed technologies are at TRL 6 or higher. This legislation does allow waivers but requires that the Milestone Decision Authority notify Congress within 30 days of the waiver approval. The effect will be to reduce the likelihood of program delay or failure caused by immature technology.

With the focus of DOD acquisition on Milestone B onward, the result is that Milestone A has become "optional" and is usually not held. Having a Milestone A can have a beneficial effect by:

- focusing earlier thinking on technology readiness by identifying the "critical technology elements" and "pulling" those technologies into system concepts
- providing the incentive for a more rapid transition from "A" to "B"

However, adding Milestone A cannot be allowed to put off program initiation as it is not a commitment to acquisition.

S&T executives are driven by developers and users to push technology to its limit and service laboratories have similar incentives to push technology to the next level. Thus, within the S&T environment, emphasis is more often placed on performance, without equal emphasis placed on schedule, affordability, supportability, and risk. Users, acquisition program managers, and technologists have a role in technology directions and plans but are often not working together to develop these in coordination.

Recommendations for USD (AT&L) Implementation

The core of these recommendations is to make Milestone A mandatory and, thereby, useful for both its technology and operational-concept components. Many of the foregoing problems can be remedied by focusing attention on Milestone A and the S&T program. Such focus will surely accelerate needed capability to the warfighter.

As supporting elements to the central recommendation, the following are added:

1. Plan and execute multiple technology demonstrations in order to generate more options with adequate funding to provide alternative solutions (these demonstrations will require added up-front resources, which will be more than paid back later in reduced risks, earlier fielding, and lower costs).
2. Address affordability, producibility, and supportability to surface potential future "cost killers"; create concurrent manufacturing and supportability plans and cost estimates. Figure 8 illustrates the importance of tying readiness levels (technology, manufacturing, and integration) to a "gated" milestone decision process.[4]
3. All of the above should be done with the understanding that until Milestone B has been approved, no acquisition program has been approved. A favorable Milestone A decision DOES NOT mean that a new acquisition program has been initiated.

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4 See the *Report of the Defense Science Board Task Force on The Manufacturing Technology Program: A Key to Affordably Equipping the Future Force*, February 2006.

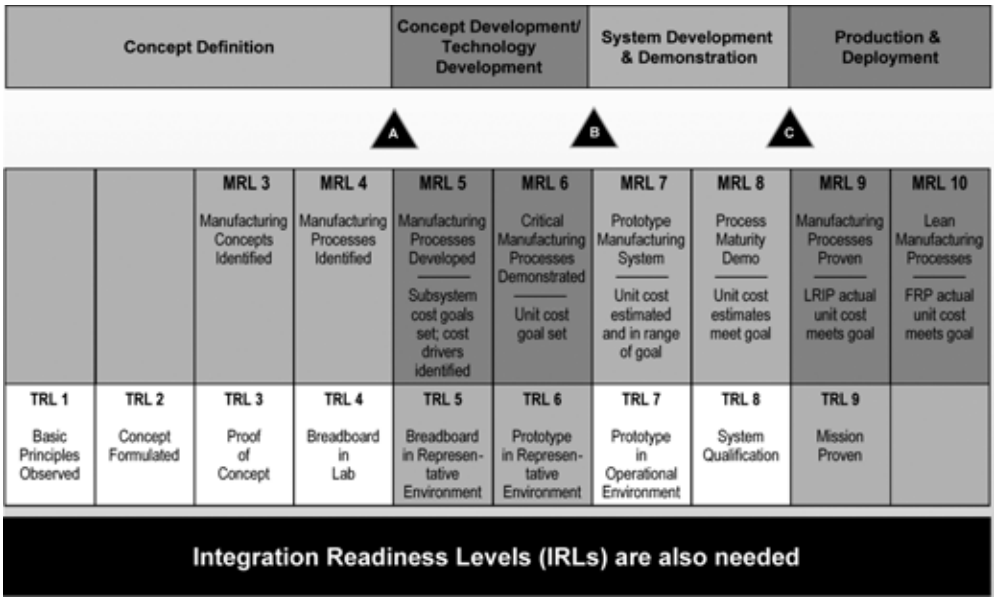

Figure 8. Readiness Levels Tied to a Gated Milestone Decision Process

4. To "realize" a strong partnership between the user (or user representative) and the program executive officer, the component S&T executive should sign a memorandum of agreement at Milestone A. During the period between Milestones A and B, the program executive officer should identify a program manager; during transition to System Development and Demonstration, the S&T executive should provide a deputy program manager. As the Milestone A to B period is completed, the user and developer need to agree that a proposed technology solution is affordable, militarily useful, and based on mature technology.
5. An independent red team (or teams if needed) should provide the service, DDR&E, and USD (AT&L) its judgment of technology, manufacturing, and integration readiness level maturity and the probability of success of risk mitigation efforts for the critical technologies. More generally, the readiness assessment should also assess the health of the program and the likelihood of its success in meeting performance, cost, and schedule goals at acceptable risk.

6. The service S&T executive (and/or DDR&E) should be the driving force in organizing Milestone A. DDR&E should be informed of service Milestone A plans, implementations, and progress.

Program Acquisition

The traditional acquisition process, from program formulation to system realization, takes too long—on the average 10–15 years (in some cases even longer). Acquisition costs are high and generally exceed early budget estimates. The result is that systems are delivered later than needed, program cost growth is funded by destabilizing other programs, technology is obsolete by the time of fielding, and quantities are reduced because of cost growth.

There is still a place for traditional acquisition. However, it needs to be improved in order to achieve faster deployment of capability at lower costs. This section puts forth recommendations toward this end.

Observations

The traditional acquisition process is necessary for the acquisition of large, complex systems that require significant engineering, design, and development. Typical characteristics of such systems include the following:

- will be used for a long time
- are complex and expensive
- require significant systems engineering
- are peculiar to the military—are not available from a commercial catalog
- have major software as well as hardware content
- may require in-the-field maintenance

The requirements and acquisition processes associated with traditional acquisition are prescribed in considerable detail in department documentation. The requirements are established according to the JCIDS, as set forth in CJCSI 3170.01E. (A previous section of this

chapter addresses needed changes to the requirements process.) The acquisition process is set forth in DOD Directive 5000.1 and DOD Instruction 5000.2 and the accompanying *Defense Acquisition Guidebook*. These documents will need significant modification to be consistent with the approach described below.

The GAO has criticized the DOD acquisition process on numerous occasions, including their March 2005 report, *Defense Acquisitions: Assessment of Selected Major Weapon Systems*. They cite the following characteristics of successful programs:

- mature technology at program initiation, stable designs, production processes that are mature and in control
- S&T organizations being responsible for maturing technologies, rather than the program or product development managers

The GAO stated that, of the nine programs scheduled to hold design reviews in the following year, only two were expected to have mature technologies at the time of the review. They claimed there was often little program visibility or knowledge of the maturity levels. The report documents the impact of immature technology on program development, shown in Table 4.

The panel agrees with the general thrust of the GAO report.

Table 4. Impact of Immature Technology on Program Development

Based on 54 programs	Technology Status at Beginning of Development	
	Mature	Immature
RDT&E Cost Increase	9%	41%
Acquisition Unit Cost Increase	<1%	21%
Average Schedule Delay	7 months	13 months

Source: Government Accountability Office, March 2005.

Many traditional acquisition programs have a number of common problems. First, the original program plan often tries to accomplish too much "in one bite." It does not take advantage of incremental ("spiral" or "block") acquisition. Further, requirements may grow during the course of development, and funding may be reduced by Congress or the department. Such changes cause replanning with accompanying delay and cost growth. As the schedule grows, there is likely to be new technology coming along (making the technology in the development system obsolete) and/or there is likely to be a changed mission requirement, causing "requirements creep" and further delay. The impact of these conditions is illustrated in Figure 9, which indicates the desirability of aiming the initial development-to-deployment cycle at somewhere around five years.

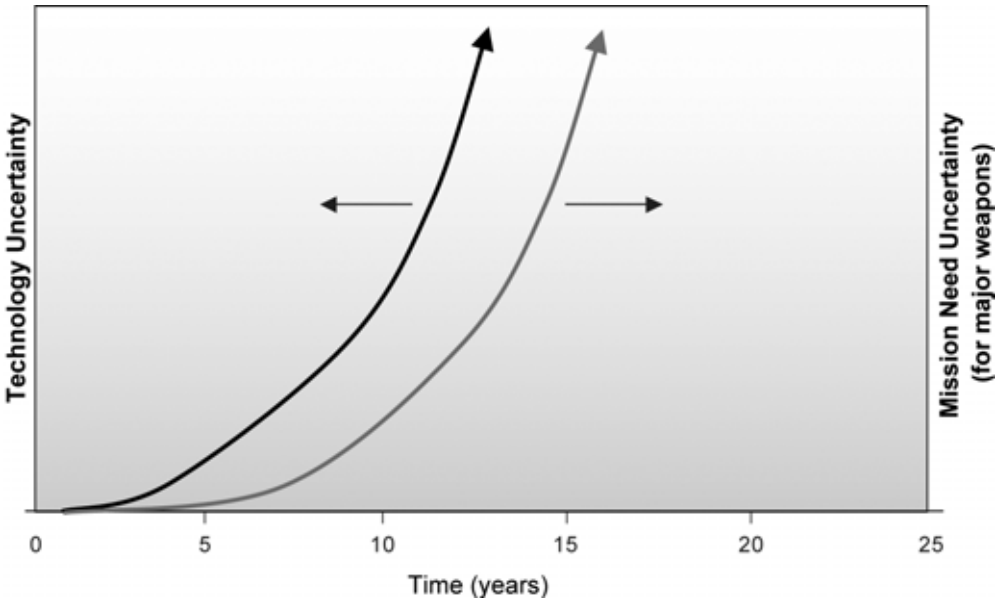

Figure 9. Time versus Uncertainty

Another common problem is that the contractor may not execute according to the planned schedule, and hence the program lengthens with commensurate cost growth. Reasons include the following:

- overly complex requirements
- overly optimistic cost and schedule estimates
- immature technology
- unanticipated software and system integration problems
- lack of the anticipated workforce
- government unwillingness to or delay in relaxing requirements
- funding instability
- growth in requirements
- inadequate early consideration of transition-to-production issues
- lack of consideration of affordability, producibility, or sustainability during the S&T phase

The result is that historic cycle times for new program starts have, over the 1996 to 1999 period, averaged well over 10 years, as shown in Figure 10. As is also shown in Table 5, many important programs, over the last decade and with increasing frequency, have had even longer actual cycle times.

In addition, programs are not designed for minimum schedules, because the service is not willing to commit the necessary annual funding. This results to a certain degree from the services starting more programs than they can afford to fund at levels consistent with a minimum schedule.

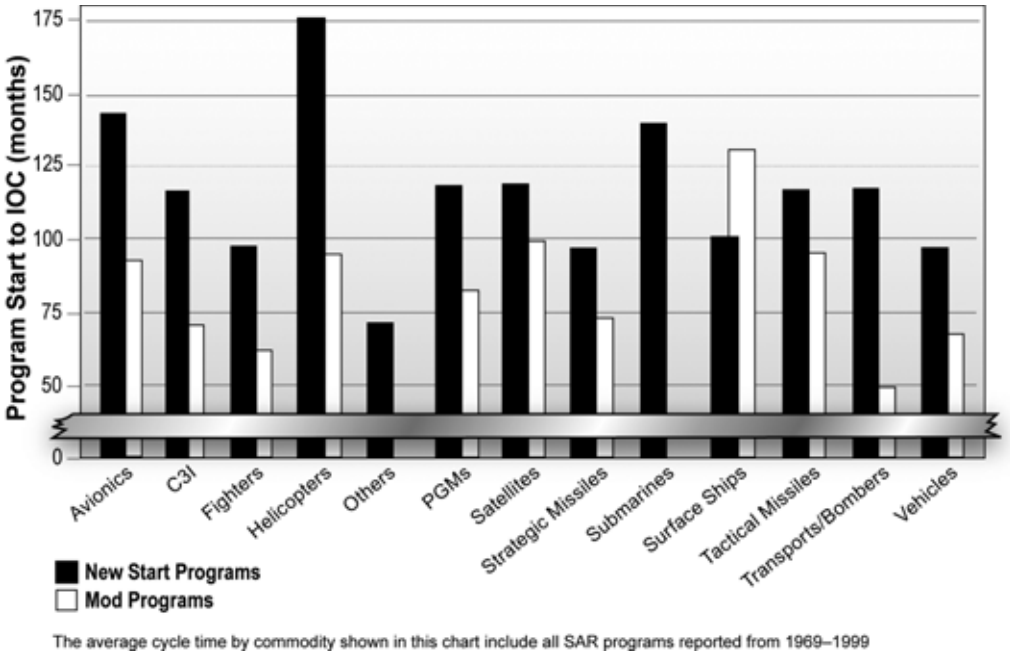

Figure 10. Average Historic Commodity Cycle Time

Table 5. Examples of Long Cycle Time over the Past Decade

Program	End Item	Commodity	Services	IOC/FUE	Time to IOC	
					Months	Years
AWACS RSIP (E-3)	RSIP MOD	Transport/Aircraft	Air Force	Dec 2006	168	14.0
F-22A	F-22 Raptor	C3I	Air Force	Dec 2005	174	14.5
MH-60R	Multi-Mission Helicptor	Helicopter	Navy	Dec 2005	149	12.4
MIDS	MIDS-LVT	C3I	DOD	Sep 2003	117	9.8
SM 2 (BLKS I–IV)	SM-2 BLK IV	Missile	Navy	Aug 1999	156	13.0
JSTARS	JSTARS	Transport Aircraft	Air Force	Dec 1997	147	12.3
FMTV	FMTV	Transport Vehicle	Army	Jan 1996	104	8.7
NESP	NAVY EHF SATCO PROGRAM	Satellite	Navy	Apr 1994	147	12.3
NAVSTAR GPS	NAVSTAR GPS User Equip	Satellite	Air Force	Mar 1993	165	13.8
DDG 51	DDG 51 Program	Ship	Navy	Feb 1993	110	9.2
LHD 1	LHD	Ship	Navy	Nov 1990	100	8.3
NAVSTAR	NAVSTAR GPS Satellite	Satellite	Air Force	Apr 1990	130	10.8

The most recent review of the traditional acquisition process was the Defense Acquisition Performance Assessment.[5] The findings and recommendations provide some good bases for improvements. They include:

- planning the time from Milestone B to initial operational capability to be no greater than 6 years
- greater user involvement in the acquisition process
- budget flexibility to accelerate programs and later spirals
- greater visibility by the department leadership into technology maturity
- the use of "spiral development" as the norm

Spiral Development

What is "spiral development"? DOD Instruction 5000.2 defines spiral development as a process where "a desired capability is identified, but the end-state requirements are not known at program initiation. Those requirements are refined through demonstration and risk management; there is continuous user feedback; and each increment provides the user the best possible capability available in a reasonable time. The requirements for future increments depend on feedback from users and technology maturation." The panel concurs with that definition, and believes that traditional acquisition programs should follow that process.

Figure 11 illustrates spiral development. The initial increment or block is designed to provide a militarily useful capability quickly and with low risk. Its KPPs are based on essentially-proven technology (TRL 6 or better). R&D to support future blocks is ongoing, and when ready, milestones for development (and subsequently production) of future blocks are conducted. Adequate funding is provided for research, development, and procurement of all blocks.

5. Defense Acquisition Performance Assessment Report, January 2006.

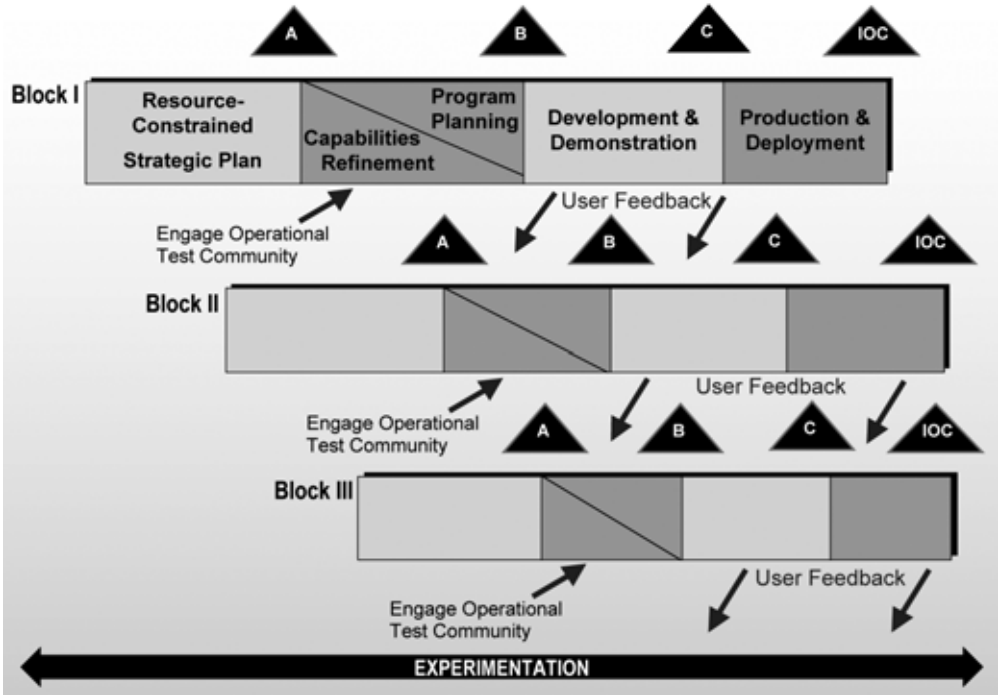

Figure 11. Spiral Development

Figure 12 compares the two ways of developing and procuring capability. On the left is the one-step or "all at once" approach, which is aimed at meeting the system's ultimate requirements at the time of initial deployment. The chart on the right illustrates spiral development, where the system is developed, procured, and deployed in blocks. The initial blocks in this case are completed significantly sooner than in the one-step case, thereby getting enhanced capability to the field sooner. Experience shows that there is also about a one-third cost saving, because of the greater achievability of the lower-risk development of the successive blocks.

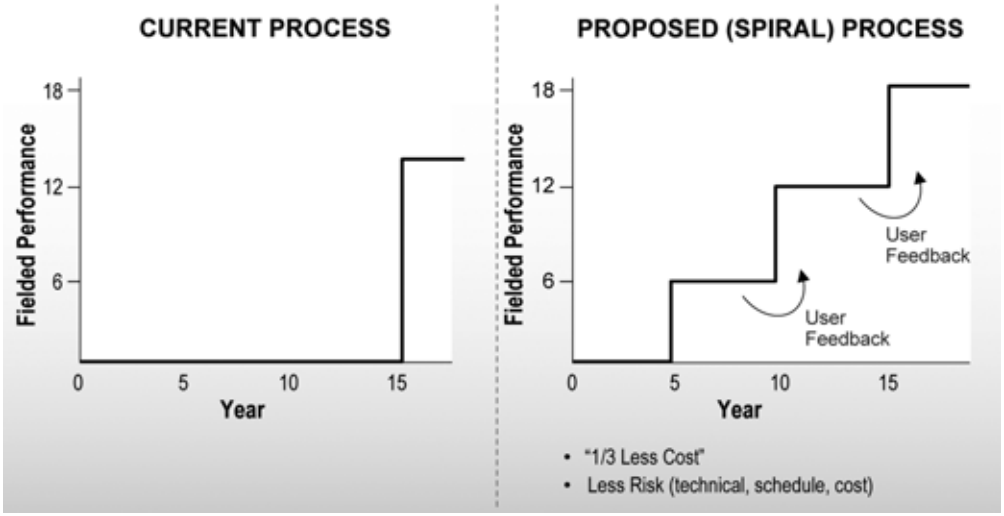

Figure 12. Near-Term Fielded Capability

Recommendations

The panel recommends that the USD (AT&L) direct the following for "traditional" acquisition programs:

- **Mandate the use of spiral development, entering system design and demonstration (SDD) of each block, with mature technology, manufacturing, and integration readiness levels**—technology and manufacturing level 6, and an equivalent level of integration readiness; plan the program to provide the initial operational capability of each block within five years of the initiation of SDD of that block.
  - Establish readily achievable requirements for a militarily-useful initial block, and be willing to review and relax requirements for that and subsequent blocks, as necessary, to protect schedule and cost.
  - Minimize required physical testing by the extensive use of modeling and simulation, reducing cost and the time required for development and testing.

  - Base the program plan on a realistic schedule with realistic cost estimates (such as estimates provided by the Cost Analysis Improvement Group).
  - Defer all but absolutely necessary changes to "requirements" and to the design until subsequent blocks.
- Design programs for minimum schedule. Do not start a program until funding consistent with that schedule is available.
- Provide program stability in
  - funding—the *sine qua non*
  - requirements
  - adequately experienced workforce and program management through a predefined phase of the program
- Adequate resources for up-front R&D on future blocks, running concurrently with the development of prior blocks to
  - maintain a competitive environment
  - reduce future risks
  - assume that there will, in fact, be a future opportunity to insert advanced technology (without having to force it into the current block)
- A modular, open-system approach, so that capability can be readily added to the basic system.
  - If future improvements are known in advance, program for pre-planned upgrades.
  - If not, be prepared to incorporate spiral upgrades as dictated by
    - demonstrations of necessary technologies
    - changing operational needs
    - availability of funding (will require a Congressionally approved wedge for application to future spiral upgrades)

- Use truly independent, expert review teams for sanity checks.

Final Observations

It is important to recognize that spiral (incremental) acquisition is different from one-step acquisition. Changes will be required in many processes:

- **Budget.** Funding will need to be provided for all phases of each block of research, development, production, and sustainment—which will overlap.
- **Requirements.** Users will need to live with the more limited capability of the initial block(s), recognizing that they may not have their "full" requirements satisfied until the fielding of a later block.
- **Acquisition.** Milestones A, B, and C will be established for each block. Milestones A and B in particular need to be strengthened to ensure adequate maturity in technology, manufacturing, and integration before concept approval, and especially before entering SDD for each block.
- **Experimentation.** Especially in cases where new technologies and concepts are introduced, experiments are necessary to provide a sound basis for their introduction.
- **Test and evaluation.** Test and evaluation should focus on military utility as opposed to a pre-set "requirement" specification.
- **Logistics.** Logistics could potentially be complicated by the introduction of successive blocks. Careful planning and innovative methods—such as performance-based logistics—will be needed to avoid bogging down the logistics system. However, logistics could also be simpler since overly complex equipment will not be introduced in a single step and fewer obsolete components, that cannot be sourced, will be introduced. (In many cases the upgrades will be retrofitted into prior blocks.)

- **Operational planning.** Planners and users will need to be aware and take account of the implications of the introduction of successive blocks, to maximize the benefits of each block, or spiral, as it is fielded.
- **Training.** Training will need to mirror the operational planning and technology evolution processes.
- **Assessments.** Net technical assessments and risk assessments should be conducted by block.
- **User feedback.** Feedback from operational units on the utility of and problems with early blocks should be used in the design of later blocks, as well as modification of operational planning and training.

Chapter 4. Disruptive Programs

The dictionary defines "disruptive" as the adjective form of the verb disrupt, which means to (a) interrupt, (b) separate forcefully, or (c) shatter. In application to the subject matter at hand, one might describe "stealth" as an enabling platform and force to "shatter" the cohesiveness of integrated air defense systems and having the additional ability to "separate forcefully" essential linked capabilities of surface-to-air missile systems to engage stealth platforms. To continue the examples, large-scale integrated circuits could be regarded as disruptive when they are employed to shatter the cost barriers that limit pervasive and large-scale networks and processing advances.

A more general discussion of disruptive technologies and/or capabilities is found in the work of Harvard Business School Professor Clayton Christenson.[6] Essentially these technologies are disruptive to current organizations and cultures and/or are "game changers" in their application—an example of which is the case of personal computers replacing mainframes. Examples in the DOD world include the GPS, cruise missiles, sea-launched ballistic missiles, stealth, remotely piloted vehicles, ballistic missile defense, and nuclear weapons. Each of these systems made a major, positive change in warfighting capability, but was also highly disruptive to the existing organizations and cultures—unmanned systems versus piloted aircraft and cruise missiles versus penetrating bombers are two such examples.

As would be expected for such counter-cultural cases, the obstacles to funding and developing such systems is much greater than for the next generation of a traditional system. These obstacles are predominantly a lack of understanding of the potential on the part of senior leaders and the effects of cultural resistance. Often it takes a fielded prototype in the right setting (sometimes in war) to break through the cultural barrier and get a well-understood message "up the

6. Clayton M. Christenson, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press: Boston, Mass. 1997.

chain of command." In almost all cases, deploying a disruptive capability has required very strong, high-level support, as well as an ability to overcome the institutional systems—which, as expected, will fight fearfully to resist the cultural change.

Recommendations

Because of their crucial importance, disruptive technologies and/or capabilities that could be fielded by the United States or employed against the United States need senior leadership attention. Thus, the DOD senior leadership (including the Secretary and Deputy Secretary of Defense, USD (AT&L), VCJCS, and service secretaries and chiefs) should receive frequent updates (quarterly would be a good target) on the disruptive potential of threats as well as the potential for, and status of, fielding of U.S. disruptive innovations.

The continuing search for challenges and innovations on both sides of the equation lies explicitly with DARPA, whose mission is to explore technological surprise and breakthroughs that underwrite U.S. disruptive innovations, drawing on U.S. foreign and global possibilities. The intelligence community has a responsibility to look for and report on the disruptive activities of other countries and their potential as threats.

DDR&E and service science and technology organizations have a dual responsibility somewhat similar to that of DARPA, to search out and exploit U.S. commercial and foreign technologies with disruptive potential. It should also be noted that there are analogous efforts ongoing at the Defense Threat Reduction Agency, with a focus on weapons of mass destruction, and the DOE-DOD shared activity, the National Nuclear Security Agency, with a focus on nuclear matters. These agencies have efforts including cooperative threat reduction, which draws technical information from foreign scientists and engineers.

The panel recommends the following:

- **DARPA focus full attention on their central two-sided mission of technology surprise and high-payoff/high-risk disruptive innovations.**

- **The DDR&E make disruptive potential (two-sided) a priority area of activity and its broad-based focal point. Working with the service communities, it should commit an additional $200 million per year to this crucial area.** The DDR&E should also consult regularly with Defense Threat Reduction Agency and National Nuclear Security Agency experts on nuclear and weapons of mass destruction matters.

Chapter 5. Cross-Cutting Enablers

In addition to the specific recommendations described in the previous chapters, there is a set of cross-cutting "enablers" that need to be enhanced if the department is to achieve the needed transformation to more rapidly, effectively, and affordably field new technologies to the fighting forces. These enablers fall in the following areas:

- human resources
- systems engineering
- budgets
- technology reach
- industrial base
- incentives

This chapter describes recommendations in these six areas, beginning with human resources.

Human Resources

There is remarkable coherence among many studies about the state of the K-12 education system in the United States and the solutions to the problem.[7] In its 2001 report, the Hart-Rudman Commission raises the problem to the status of a national security crisis: "Second only to a weapon of mass destruction detonating in an American city, we see nothing more dangerous than failure to properly manage science, technology and education … The inadequacies of our systems of research

7. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future*, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies, October, 2005; *National Defense Education and Innovation Initiative: Meeting America's Economic and Security Challenges in the 21st Century*, American Association of Universities, January 2006; *Losing the Competitive Advantage? The Challenge for Science and Technology in the United States*, AeA, August 2006.

and education pose a greater threat to our national security… than any conventional war."[8]

In the view of the panel, this characterization is an accurate portrayal of the problem, which amounts to a loss of America's strategic advantage.

Many surveys and statistics illustrate the crisis in U.S. education. One of the starkest is provided in *Education at a Glance, 2005*, by the Organisation for Economic Co-operation and Development.[9] This report presents data on educational achievements in thirty industrialized countries. The data show that for the cohort aged 45 through 54, the U.S. population is the best educated in the world: #1 in percent that completed high school and #2 in percent that completed college. The looming crisis is illustrated by the corresponding statistics for the 25 through 34-year-old age group. The U.S. cohort ranks #9 in terms of high school completion and #8 for college. Worse, the United States is the only country in the survey where the younger cohort is actually less well-educated, in terms of actual percentage of graduates, than the older one.

The problem is most severe, and of greatest importance, in math and science. Many math and science courses, particularly at the high school level, are taught by teachers who have had little academic preparation in these fields. This out-of-field teaching seems to be on the rise.[10] The net result is that America's high school graduates are not ready for American universities in the math, science, and engineering areas.

Paradoxically, U.S. higher education in science and technology continues to be the envy of the world. In 2004, China's Shanghai Jiao Tong University compiled a ranking of the world's universities. Of their

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8. *Road Map for National Security: Imperative for Change*, Phase III Report of the U.S. Commission on National Security / 21st Century, February 15, 2001.

9. *Education at a Glance 2005*, Organisation for Economic Co-operation and Development, September 13, 2005. http://www.oecd.org/document/11/0,2340,en_2825_495609_35321099_1_1_1_1,00.html

10. "Science and Engineering Indicators 2006," National Science Foundation.

top 20, 17 are American universities.[11] Of the internationally mobile student population, 40 percent attend universities in the United States. This statistic compares to 18 percent in the United Kingdom, 15 percent in Germany, 12 percent in France, and 6 percent in Australia.

But it is the future that is of great concern. As observed in a recent National Academies report: "The scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength … This nation must prepare with great urgency to preserve its strategic and economic security."[12]

James A. Lewis observes that the situation today is more complex than when Sputnik took America by surprise in 1957.[13] It is in the U.S. interest for other countries to grow economically and perforce to grow technologically. Therefore the likelihood for technological surprise is greater today than fifty years ago, so maintaining the U.S. strategic advantage is all the more difficult—and imperative.

While the consensus that there is a problem is quite broad, some contend that the solution lies in reducing barriers to immigration for those who have needed skills—or retaining those who are attending U.S. schools. After all, historically half, or more, of students on temporary visas have stayed in the United States immediately after getting their degree, and this percentage has risen in recent years. In the period from 1992 to 1995, 68 percent of foreign science and engineering doctoral degree recipients stated they planned to remain in the United States after receiving their degrees; by 2000–2003, 74 percent intended to stay. Students on temporary visas earned about one-third (32 percent) of all science and engineering doctorates awarded in the United States in 2003 (and more in some fields). More than half (55 percent) of engineering doctorates were awarded to students on temporary visas.

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11. http://www.economist.com/markets/displayStory.cfm?story_id=3154661

12. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future*, October 2005.

13. James A. Lewis, *Waiting for Sputnik: Basic Research and Strategic Competition*, Center for Strategic and International Studies, October 2005.

This strategy is certainly part of the solution. Indeed, immigration has been a key element of the U.S. strategic advantage in science and technology; one-third of all U.S. Nobel Prize winners were immigrants. But the immigration strategy does not suffice for DOD's needs.[14] It is undoubtedly more difficult for foreign-born citizens to obtain security clearances. So it is more than a matter of principle that we fix the problems in K-12 education.

DOD is among the most vulnerable institutions to the impending shortage of highly trained engineers and scientists. The DOD civilian acquisition corps is particularly vulnerable due to an aging workforce, outsourcing of research, and non-competitive pay. There is little career development or education (as opposed to training) available for civil servants. The situation for the military acquisition workforce is much the same and, in fact, has deteriorated from a previous time. (In the late 1960s, the Air Force ran a Blue Room that was focused on the acquisition officer corps that assured the best talent was available to manage that service's programs.)

There are three specific skill sets that the panel believes are in critically short supply in the DOD acquisition corps. One is system engineering, but this skill set includes a broader set of disciplines including systems analysis and system-of-systems engineering. The second is biological science. The third is a broad subset of social sciences that deals with organized human behaviors and is identified in other volumes of this study as a critical new capability area.

Recommendations

1. The panel recommends that a dedicated career development organization be instituted for DOD's technical workforce—military and, especially, civilian.

Career development means developing and sustaining the existing workforce, as well as developing and executing recruitment strategies

14. *National Security Workforce: Challenges and Solutions*, Director of Defense Research and Engineering, 2005.

for the future. For the existing workforce, best practices should be borrowed from industry to effectively indoctrinate and integrate new workers. The career development entity should advocate improved security clearance policy, including a more expeditious clearance process and true reciprocity both within and across agencies, to enable workers to be productive early in their employment. It should enable rotation between industry and government jobs, where appropriate and advantageous.

Career development also includes identifying the best candidates for advancement, and assuring that they get the experience, exposure, and training that they need. Continuing education and rotation opportunities should be tailored to meet near-term skill needs. Retention incentives such as flexible work schedules, non-monetary recognition schemes, and opportunities for part-time work without disproportionate retirement penalty, should be instituted. For the future workforce, the career development organization needs to be closely coupled with the outreach programs described below.

2. Misinterpretation of existing authorities that provide for rotating government and industry personnel needs to be reversed so that these programs can be effectively used to enhance careers and improve performance.

Existing authorities provide for rotating government and industry personnel. However, recently rules governing the ability of private sector individuals, who have come into government under the Intergovernmental Personnel Act (IPA), to move from government back to industry have been punitively misinterpreted, to the detriment of such personnel. Similarly, there are existing authorities that can be used to provide professional development and education for DOD civilian employees. This is an important incentive to government employment. But the disincentives to authorize such benefits need to be removed. Staff should be sized to workload, taking into account the 10 percent or so of the time employees will be away, so that these opportunities do not break morale.

3. Retool the Defense Systems Management College and the Defense Acquisition University to focus on best practices for acquisition outcomes and to incorporate lessons learned from the field.

4. Initiate a sustained outreach program to attract highly qualified scientists and engineers into the workforce.

Hart-Rudman Phase III observed: "While some have argued that the 'Generation X' cohort is less inclined toward government employment, our analysis suggests that this cohort does see government as one of several desirable career tracks. If recruiting were resumed, many within this age group would seek federal jobs. This is suggested by the fact that the one current mechanism for bringing graduate students into government—the Presidential Management Internship program—has remained highly competitive."

The most important element of the outreach is higher education. The Science, Math, and Research for Transformation (SMART) National Defense Education Program (NDEP) is a new program, mandated by Congress in 2005. This program should be protected, expanded, and targeted to the most critical DOD needs. It is currently funded at only $19 million, but is budgeted to grow to $74 million in 2011. We strongly urge that this program be protected.

Internship opportunities should go hand-in-hand with NDEP grants to foster early institutional ties. DOD can effect a huge change in early motivations to study science and math by (1) committing to sponsor a large-scale high school internship program for sophomores through seniors; (2) implementing reimbursements through its contractors and in-house technical organizations and their people; and (3) setting the goal of reaching 50,000 to 100,000 high school students per year who work with scientists and engineers as summer interns, and earn an average of $2,000 over a period of 10 to 12 weeks.

The logic for the internship with industry and government organizations is simple. It is people-to-people based—the personal mentor model—which is likely to be the highest yield mechanism. Why the large number of interns and what will it cost? The United States at

300,000,000 people has 3,000,000 scientists and engineers, including those who teach at college and levels above. On the average, a replacement rate of 75,000 people a year is needed in the near term to balance retirees who have a 40-year career.

A $2,000 summer internship today competes more than favorably with short-term minimum wage employment available to high school students. Employing 75,000 interns per year would cost $150 million annually, approximately 0.1 percent of the DOD expenditures for contracting and funding internal technical organizations. This investment is very small, but highly leveraged. It should be reimbursable with encouragement to all involved organizations to do more. It should also have tracking potential for assessment and fine-tuning—to include even e-mail inputs, properly filtered to maintain contact as interns select education and career paths.

This initiative does not replace the 21st Century National Defense Education Act, NDEP scholarships, and other initiatives, but should be pursued in addition to these. The intern program is a feeder initiative for others. Additionally, inexpensive sponsorship opportunities that DOD should consider are science fairs and new media, such as podcasts (USJFCOM just started producing a series) and online virtual worlds.

Finally, the problem of producing the needed technical workforce should be solved at the national level. There is strong consensus on how to do it, but the process must begin now.

System Engineering

System engineering is the process responsible for managing the trade-offs necessary to develop and field a system that is affordable, is sustainable, is delivered on schedule, satisfies user needs, and minimizes risk. The term "system" applies to technology, sub-systems, a system (as the term is generally used, as in weapon system or command and control system), and system-of-systems, as these all interact with their environments and are complex assemblages of interacting components whose development requires trade-offs. It also includes the concepts of operation, training, sustainment, and eventual disposal of the system.

In the context of this study, system engineering applies to all modes of acquisition that are considered: rapid acquisition; traditional acquisition in its pre-Milestone A requirements trade-off phase, its technology development Milestone A to B phase, and its system design and development Milestone B to C phase; as well as to disruptive acquisitions. Put more broadly, system engineering applies throughout the life cycle of a system—that is from the inception of mission need identification through and including system retirement. Further, it applies irrespective of system development style (such as waterfall, pre-planned product development, or spiral, for example).

System engineering is a professional field with tools and techniques acquired through education, training, mentoring, and experience. The selection and application of the appropriate system engineering measures will vary with circumstance—such as the technologies inherent in a system, the development status of the system, and the mode of acquisition being used. The field of system engineering, as used in this report, incorporates the following as sub-fields: system analysis, system architecture, system test, verification and validation, risk mitigation and management, and virtual (system modeling and simulation driven) engineering and product development. In some contexts, software engineering and, in other contexts, configuration management is properly included in system engineering.

However, it is one thing to identify system engineering as a critical function for the realization of systems, yet another to assess whether system engineering, as applied, is provided the responsibility, given the authority, and held accountable for the accomplishment of its functions.

Findings

The findings presented in this section are derived from the experiences and observations of the panel members of this DSB study, and supported by applicable studies and reports, to include the recent

Defense Acquisition Personnel Assessment Report and the previous DSB reports.[15]

DOD system engineering capability has significantly degraded over the past 20 years, an unintended consequence of actions taken for other reasons. Aggravating this situation were the manpower ceilings that were placed on the acquisition workforce following the collapse of the Soviet Union, which were intended to induce economies without harmful effect. The anticipated reduction of serious future threats led to a consequent reduction in the need for DOD acquisition (including system engineering) personnel.

In parallel, the philosophy of government outsourcing was vigorously embraced, to the extent that many previously understood, inherently governmental DOD system engineering functions were outsourced to private contractors. Thus outsourcing led to a reduction in the need for DOD system engineering personnel, and dampened any arguments that were made that the acquisition manpower ceilings had already reduced DOD system engineering too far. Acquisition reform, as interpreted in that time period, played a further role, as its zeal in some quarters for "insight" versus "oversight" further reduced the DOD system engineering function to one of estranged observer with minimal significant participation.

The net result of the manpower ceilings, extreme outsourcing, and changed role was not only to reduce the number of DOD system engineers, but also to serve as a deterrent to new technical personnel entering that field. Market forces and career growth played their expected roles. As senior, experienced, DOD system engineers retired, or left the field through transfers, the resulting vacuum was not filled.

The need for system engineering has evolved differently than envisioned. The threat has not gone away but has been replaced by a more varied and complex threat, requiring more systems and more

15. *The Defense Acquisition Performance Assessment Final Report*, March 21 2006, and *Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on the Acquisition of National Security Space Programs*, OUSD (AT&L), Tom Young, Chairman, May 2003.

sophisticated systems-of-systems to implement current military operational concepts, such as network-centric warfare. This in turn, creates demand for an increased number of competent DOD system engineers, versed and experienced in best practices. In addition, current understanding is that "insight" had gone too far, and was associated with some of the most grave acquisition failures recently experienced in the department. The current lack of adequate DOD system engineering is apparent, and correlates with programs in serious trouble.

Thus, the DOD system engineering workforce has deteriorated in capability. It is too small, not adequately empowered for the tasks at hand, and too often uses processes and procedures that have not been validated as short cuts to compensate for the lack of resources to accomplish system engineering tasks. Program management offices are understaffed in system engineering and are limited in their ability to perform. The DOD cannot function with the expertise required to act as a "smart buyer," one of its most critical functions, in such activities as formulating requests for proposals, evaluating proposals, and providing technical direction to programs.

It will take time and well-resourced, informed action to correct the current state of affairs.

Recommendations

The panel's specific recommendations fall in five general categories: 1) provide systems engineering the responsibility, authority, and accountability it needs to perform; 2) manage system-of-systems engineering at the proper level; 3) rebuild the system engineering workforce; 4) conduct research to develop better system engineering tools; and 5) assess the quality of system engineering using truly independent "red teams."

1. Re-establish the program level position of chief system engineer, properly resourced and reporting at a senior program level.

Chief system engineers have fallen out of vogue as integrated product teams (IPT) and, in particular, system engineering integrating teams (SEIT) have overtaken much of that function. Where something like a chief system engineer exists, they are often only process experts,

assuring that all those involved in the system engineering function follow a published (not always correct) process. This recommendation requires the chief system engineer to be a subject matter expert as well as a process expert, responsible and accountable for life cycle trade-space management and all system engineering decisions and actions. The chief system engineer reports at a senior program level and has the authority to oversee and, if necessary, re-direct decisions made by system engineering IPTs and SEITs. This individual should also institute and manage a process that assures awareness of and involvement in these teams.

The chief system engineer needs to assure that modeling and simulation play a proper role in system development. This includes creating simulation models for experimental design in the early phases of a program when there are no physical counterparts, and the use of physical test and validated models to explore the trade space and evaluate alternatives in an accelerated and affordable way. The chief system engineer should also assure that a reasonable and coordinated allocation of system engineering responsibility flows from the DOD to the prime contractor's lead systems integrator and from there to the sub-contractors, including oversight of make-or-buy decisions and attaining required program system-of-systems interoperability.

To succeed, the chief system engineer needs to create a close positive relationship on matters effecting life cycle system engineering with those generating system requirements, those that will benefit from the consequences of system engineering, and those conducting independent tests of system performance. As such, the chief system engineer will need to forge these relationships through conferencing and other collaborative means with users, testers, and maintainers—from the beginning of development and throughout the period of program performance.

2. Designate a chief systems-of-systems engineer to assure systems-of-systems optimization (versus component system optimization), overseen by a designated authority reporting to the USD (AT&L). This is particularly critical in multi-service systems, but applies equally for a single service system-of-systems.

A program chief system engineer, as discussed above, will assure attainment of the interoperability KPPs as assigned to the program. Systems-of-systems are often broken into separate component systems with no cost-effective optimization of the elements, or even with no integrating responsibility assigned, that would assure that the component systems are properly coordinated to achieve the best system-of-systems performance. For example, spacecraft often work with and though ground terminals and comprise with them a system-of-systems, but are often broken out as separate programs to achieve separate destinies. This recommendation will provide the necessary systems-of-systems responsibility and authority, and, if properly resourced, capability.

3. Rebuild the system engineering workforce.

The system engineering workforce needs to be rebuilt in both industry and government. The panel focuses, in this report, on the need within DOD.

System engineering careers need to be actively managed with appropriate incentives, including, where possible, higher pay grades and better opportunities for advancement. Systems engineering attainment must positively count for advancement. System engineers should be recruited from the best sources to include the best undergraduate schools and qualified applicants from industry. DOD system engineers must be given as good or better opportunities as their counterparts in industry for quality graduate education at the best schools (through distance and on-campus means) and the opportunity to participate in quality professional societies and activities. DOD system engineers should have the hands-on experience working in the DOD and industry system integration laboratories constructed and operated to support major programs. They should also be trained in and use state-of-the-art system engineering tools. DOD system engineers should participate in the system engineering research activities that are discussed in the next section.

These recommendations will, in most cases, require some small additional resources—but they will pay off, and in the view of the panel, are well worth the investment.

In the interim, given the current shortage of DOD system engineers, IPAs, transfers from industry, and use of retired industry engineers should be used where appropriate.

4. Use competitive research to develop improved system engineering tools and practices.

The research-sponsoring infrastructure in the United States has been honed to support traditional fields of science, engineering, and the social sciences. Yet, despite its importance, it is woefully under-supportive of integrating fields such as system engineering. Consider the National Science Foundation's supported research as an example. Traditional institutions change with great difficulty. In implementing this recommendation, DOD should act directly to sponsor such research that is so vital to DOD success, both to create new system engineering tools and processes and to validate existing ones whose value is suspect. There are a number of private institutions and a growing number of universities that will compete for such research, given the opportunity, and such competition will provide the most qualified participants. However, some of this research needs to be performed by the DOD directly as a means to influence the direction of the field of system engineering, contribute to its development, and maintain a direct means of understanding its potential.

5. Use truly independent "red teams" to assure quality systems engineering is applied to major programs and activities.

The recommendation to use red teams for the system engineering function stems from the failure of humans, whether as individuals or in teams, to think and act in an overly conservative or narrowly focused way when under pressure. Red teams must have the ability to quickly understand and evaluate on-going activity and recommend improved means. Therefore red teams, at a minimum, should be composed of experienced and very capable subject matter experts and be empowered to fulfill their function. However, they also need what they frequently lack, professional diversity and a membership that is willing to form its recommendations through open debate and consensus-seeking with provision for minority positions.

Too often, red teams are formed with people who think alike because they all work for—or worked for—the same organization or even a part of the same organization, with token representation from others who are known to have similar opinions. It is critically important that truly independent red teams be created with members carefully selected with regard to expertise, a modicum of social skills, and professional diversity. One technique to provide diversity is to assure adequate representation from government, academia, and industry. Of paramount importance is that all the members be free of conflict of interest, which in some instances will mean that the industry participants be retired and/or without substantial stock or other ownership positions in affected companies.

Budgets

Lack of funding flexibility and adequate fiscal plans for the out years are two of the most significant impediments to accelerating technology into fielded capability. Currently, two-year budget cycles and the inadequate level of S&T reprogramming authority inhibit the pursuit of technology options that could support agile acquisition. S&T senior managers need to be able to "mercy kill" less promising technology efforts and reprogram funds to support technology options with higher potential payoff.

Progress in system development programs in the execution phase is often impeded by the lack of an adequate budget from which a program manager can create a management reserve. Such reserves are an essential tool of program managers to allow them to take timely corrective action to address risks or identified problems that always emerge in challenging major military system development efforts. Lack of management reserves results in delayed action on risks and problems, thereby increasing overall cost and cycle time.

The spiral development approach advocated in this report requires that research, development, test, and evaluation (RDT&E) plans be developed and funded to support the initial spiral and to support systems studies and S&T for future spirals. Faster, less expensive fielding of block 1 yields a technology pull that focuses the research program, thus quickening development and creating a basis for

technology prioritization. It also means, however, that since the subsequent blocks are dependent on research, that budget turbulence in the basic research portfolio can directly and adversely impact system spirals. As the Hart-Rudman Commission put it, "Program turbulence, often stemming from lack of funds or from budgetary instability, is the primary cause of inefficiencies and cost overruns in DOD programs." This will continue to be so and must be addressed.

Research funding will likely be challenged as budget pressures from war operations tighten. S&T investment is a key to providing technology options for future military systems.

Recommendations

Establish funding in the defense budget ($3 billion per year) for the new Rapid Fielding Organization and allow discretionary funds in the year of execution.

For acquisition programs, require budgeting to realistic costs and restore the practice of establishing management reserves within that budget to handle unforeseen problems while maintaining schedule and cost baselines.

Budget RDT&E funding for future spirals through the future years defense plan.

Sustain S&T funding at the fiscal year 2007 budget level in order to maintain technological superiority.

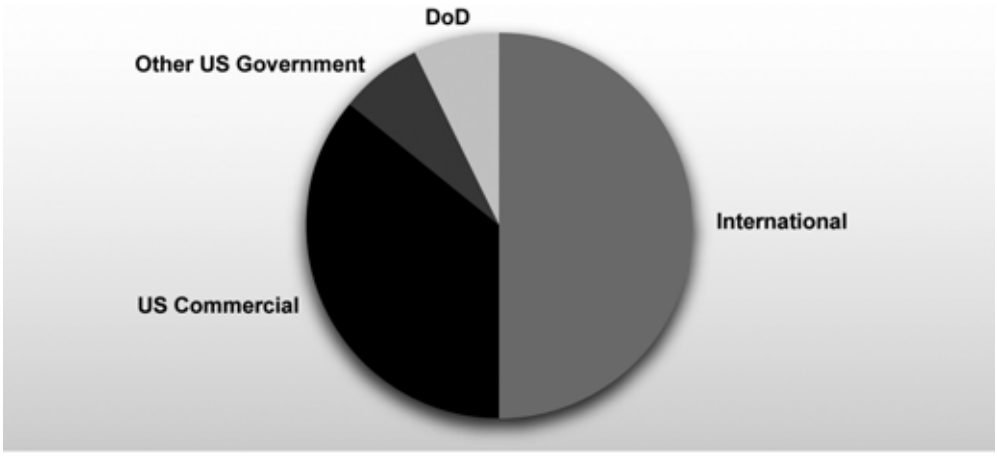
Current projections are that science and technology funding will decline by $1 billion in the out years. Of particular importance here is the support for basic research. Over the past 40 years, basic research has declined as a percentage of overall S&T from about 25 percent to 12 percent.

Technology Reach

Technology is becoming a greater and greater necessity for business competition worldwide. Because of this fact, the investment in technology is growing internationally. Currently only about half of the

world's investment in R&D is performed in the United States and this percentage is getting smaller. Twenty seven percent of U.S. R&D is funded by the federal government and less than half of that is funded by DOD. In addition, only about five percent of the scientists and engineers in the United States are directly employed by the government. Federal R&D funding has been relatively flat for the past 30 years and in fact has decreased from a peak in 1997.

In recent years, there has been a shift in U.S. DOD R&D investments from research into development. The long-term security of the nation still depends on DOD being at the leading edge of applying the newest in science and technology. In the past, such leading-edge technologies came largely from the U.S. government. That has not been the case for quite some time and, as indicated in Figure 13, much of it is now international.



Source: "International Science and Technology Trends," Pocket Databook 2000, National Science Foundation

Figure 13. Science and Technology Investment

In contrast to DOD, commercial industrial research, until recently, has been steadily increasing in both the manufacturing and non-manufacturing industries. The only industry group that receives the majority of its S&T funds from the government is the aircraft and missile sector, which is less militarily relevant today than it was during the Cold War. In the biological and social sciences, which are growing

in military importance, the DOD investment is extremely small. If DOD wants to be a leader in using technology, it needs to become very adept at finding and using the globally available resources, whether funded by industry or academia or DOD or other government agencies. The department needs to become very effective *prospectors*.

In the meantime, potential adversaries have shown themselves to be quite adept at finding technology relevant to their purposes from global sources. Partially, this is because of the transnational nature of this threat. During the Cold War, technology in the Soviet Union originated from well-known places using a well-understood process. By monitoring Soviet research and test facilities, the United States had a reasonable chance of knowing what it would be facing on the future battlefield. For today's transnational threat, there is no clear place to focus such attention. Yet the urgency is greater since U.S. adversaries do not require a long development cycle—which would otherwise create a long time period during which to observe their activities. If the DOD wants to have an idea of what path the adversary's threat is taking, it needs to more effectively track adversary interests and then rapidly develop counters to the potential threat. For this part of the challenge, the department not only needs very efficient prospectors but also skilled *expeditors*, such as the Rapid Acquisition Organization, described in Chapter 2.

As a result of major consolidations in the defense industry, as well as the increased cost-competitive nature of business in general, there has been a reduction in the amount of IR&D investments being made in the United States. In addition, the DOD has reduced its oversight of IR&D, requiring no descriptive brochures or on-site reviews, making it more difficult for DOD to be aware of what is going on, even in a DOD-related industry. The commercial industry likewise has not wanted DOD business because acquisition regulations intended to prevent corruption make doing business with the DOD very difficult; as a result, the DOD is often unaware of the developments in U.S. commercial industry.

The panel recommends, whenever appropriate, that "other transaction authority" and other means be used to enable commercial firms to more easily undertake business with the DOD. However, for

DOD to acquire foreign technology, other difficulties may also have to be overcome. Export controls are intended to prevent proliferation of dual-use technology, but they impede the integration of foreign technology and cooperation and hinder U.S. firms from obtaining scale-economics. The "Buy America Act," intended to protect U.S. business, forestall off-shoring, and assure trusted sources, restricts the use of foreign technology and hinders the development of techniques to overcome risks of buying offshore.

The lack of language skills among most U.S. scientists and engineers precludes their reading foreign journals or attending foreign-language technical conferences. Thus, there is difficulty in being aware of foreign research and development. That combines with reluctance in much of the world in supporting U.S. military interests and, in some cases, restrictions being placed on the export of technology to the United States. The panel believes that implementing the recommendations of the 1999 *Defense Science Board Task Force on Globalization and Security* will help to reduce some of these barriers to acquire foreign technology. (Appendix F lists the relevant recommendations from that study.)

As part of the Reliance process, the DOD produces Technical Area Review and Assessment reports on selected R&D topics biannually. Although these reports are very extensive, their purpose is to inform Congress of DOD research. As such, they are not designed for the purpose of sharing information among researchers. There was a document that was useful for that purpose, the DD Form 1498 (Technical Effort and Management System), but it has been discontinued by the DOD. The 1498s were generated by DOD principal investigators any time they invested in internal or contracted R&D. They described what the project was about, including its objective, approach, and progress. They identified the name and phone number of the government investigator, as well as the name of the funded company or university and its principle investigator and his or her phone number. The 1498 database was maintained by the Defense Technical Information Center and made it very convenient to know what other DOD organizations were doing and who to contact for collaboration.

Knowing who to contact for collaboration is very important if the department wishes to explore what is being done globally. The panel recommends establishing an office in DDR&E that will identify important global technology. Because of the breadth of interests by the DOD it would be cost prohibitive to attempt to fill the DDR&E organization with all of the skills needed; therefore, it is critical that the personnel in that office have a database like the 1498s that can identify the DOD experts and their interests.

The objective of the DDR&E prospecting office is to make the connection between the DOD and non-DOD scientists, so the significance of the work to the DOD can be determined. In addition to finding research and reporting it to the relevant organizations, the office can do special searches for specific research that has been identified by the DOD as of critical interest. In the mid 1960s and 1970s there was a series of Air Force scientific and technical offices located at NASA centers, as well as regional offices, throughout the United States. The DDR&E activity would be very similar to these offices except with a global prospective. Increasing collaboration between and among researchers is an extremely important role of the DDR&E office.

Collaboration is also needed in determining what research is of interest to potential adversaries. Currently there is considerable collaboration among DOD organizations when it comes to attacks on computer networks (worms, viruses, etc). There is also some effort within individual networks to determine what interests are being shown in various web topics. For the topical analysis there is little collaboration across DOD organizations even though more collaborative analysis might indicate a focus on a particular threat area. Intelligence organizations are not generally manned to do this type of analysis since it requires a detailed technical focus. The DDR&E prospecting office, with the help of the DOD scientific community, however, could do an effective job at this. As the DOD improves its competence in recognizing suspicious technical interest in web topics, it will more clearly identify the potential technical threat and ways to counter it.

Recommendations

Establish and fund a DDR&E Center for the Application of Commercial and Foreign Technology.

This office should be selectively manned with experienced DOD scientists and engineers with foreign language skills and with a strong interest in improving scientific collaboration. The office should be funded at 0.1 percent of the DOD S&T budget. Although this is a very small funding level, it is not intended to fund research. Rather, it should be sufficient to support manning a small number of staff as well as provide them travel, data acquisition, and the establishment of a searchable database.

Re-establish the DD 1498 database so that DOD S&T activities and their associated key personnel can be identified.

This database should be located at the Defense Technical Information Center and available online to all DOD scientists and engineers. These documents, less the financial information and proprietary information, should also be available to appropriately cleared U.S. contractors.

Greatly expand the use of "other transaction authority" and other means to enable commercial firms to undertake business with the DOD.

To insure that this action is taken, the USD (AT&L) should maintain a monthly report of the frequency of the use of these approaches as well as the frequency of first-time DOD contractors. Annually, the USD (AT&L) should provide an award to the contracting agency that has done the best job of reaching out to commercial and international business, similar to the Packard Award.[16]

16. The Packard Award is given to DOD civilian and/or military organizations, groups, and teams who have made highly significant contributions or demonstrated exemplary innovations and best practices in the defense acquisition process. The award, the Department's highest acquisition award, is named in honor of the late David Packard, a former deputy secretary of

To enable the contracting offices to take advantage of foreign technology requires that many of the barriers to foreign trade be eliminated. In 1999 the DSB made specific recommendations in its report on globalization and security and these recommendations are yet to be implemented. These recommendations need to be implemented as soon as possible.

The DDR&E needs to consolidate the information contained in the web logs of all DOD science and technology organizations. These logs should identify who accessed the site, when (date/time on and off), and the topics searched or viewed. DDR&E should also request web logs from other organizations such as National Aeronautics and Space Administration centers and national laboratories. Their participation would be voluntary but very valuable. DDR&E should develop procedures to review these logs and identify suspicious activity. Concerns should be reported to the pertinent organizations, so that the technical experts might confirm DDR&E perceptions and suggest actions to be taken to counter the potential threat. Over time, with the feedback from the scientists, it is anticipated that the DDR&E organizations will improve their process and generate fewer false positives.

The Industrial Base

Since the late 1980s, consolidation has been a fact of life in the defense industry. Within the free world, it played out in Germany and Great Britain as a free-market phenomenon and in France as a government-directed activity. In the United States, at the "Last Supper," the Secretary of Defense assured the leaders of industry that the Departments of Defense and State were going to lift the then-barriers to consolidation given the anticipated future reduced defense market (at the end of the Cold War). This market was at the very least government guided and facilitated and operated as a free market activity. The government has paid greatest attention to gross competitive matters, not those that result from other narrowing influences.

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defense during the Nixon administration. He was also the chairman of the President's Blue Ribbon Commission on Defense Management chartered by President Ronald Reagan in 1985.

The dramatic narrowing of industry to the current largest prime contractors is described in Figure 14. This figure (last updated in 2003) depicts how Boeing, Northrop Grumman, Raytheon, General Dynamics, and Lockheed Martin came to be as they are today.

An observation in 1997 by Lockheed Martin's Chairman, Norm Augustine, about the possible impact on second and third tier suppliers and the results of this consolidation on DOD acquisitions is an essential view. Augustine stated "…if prime contractors act on new vertical capabilities to freeze out competitors' key product, or to shut out 2nd and 3rd tier suppliers it would tend to unfairly favor the largest suppliers with the broadest component and technology base. As such this is a trend about which our government … should be evidencing a great deal of concern."[17] In some respects, this commentary and its concerns are further sharpened by the fact that these same suppliers are increasingly global (and some commercial), adding to the government's challenge.

DOD's concern for vertical integration was recently addressed in a July 2004 memorandum by Acting USD (AT&L) Wynn on "Selection of Contractors for Subsystems and Components." A key element of this concern was "When developing acquisition strategies, program managers and contracting officers shall establish insight into a prime contractor's plan for assembling a team to deliver the required system capability and foster the use of competition." Deputy Secretary of Defense England's study, *Defense Acquisition Performance Assessment*, commissioned in 2005, further portrays official DOD concern about vertical integration and adds to Augustine's commentary regarding competition for critical subsystems.

17. "Unhappy Birthday: American's Aerospace Industry at 100," *Aerospace America*, February 1997, pp. 24–31.

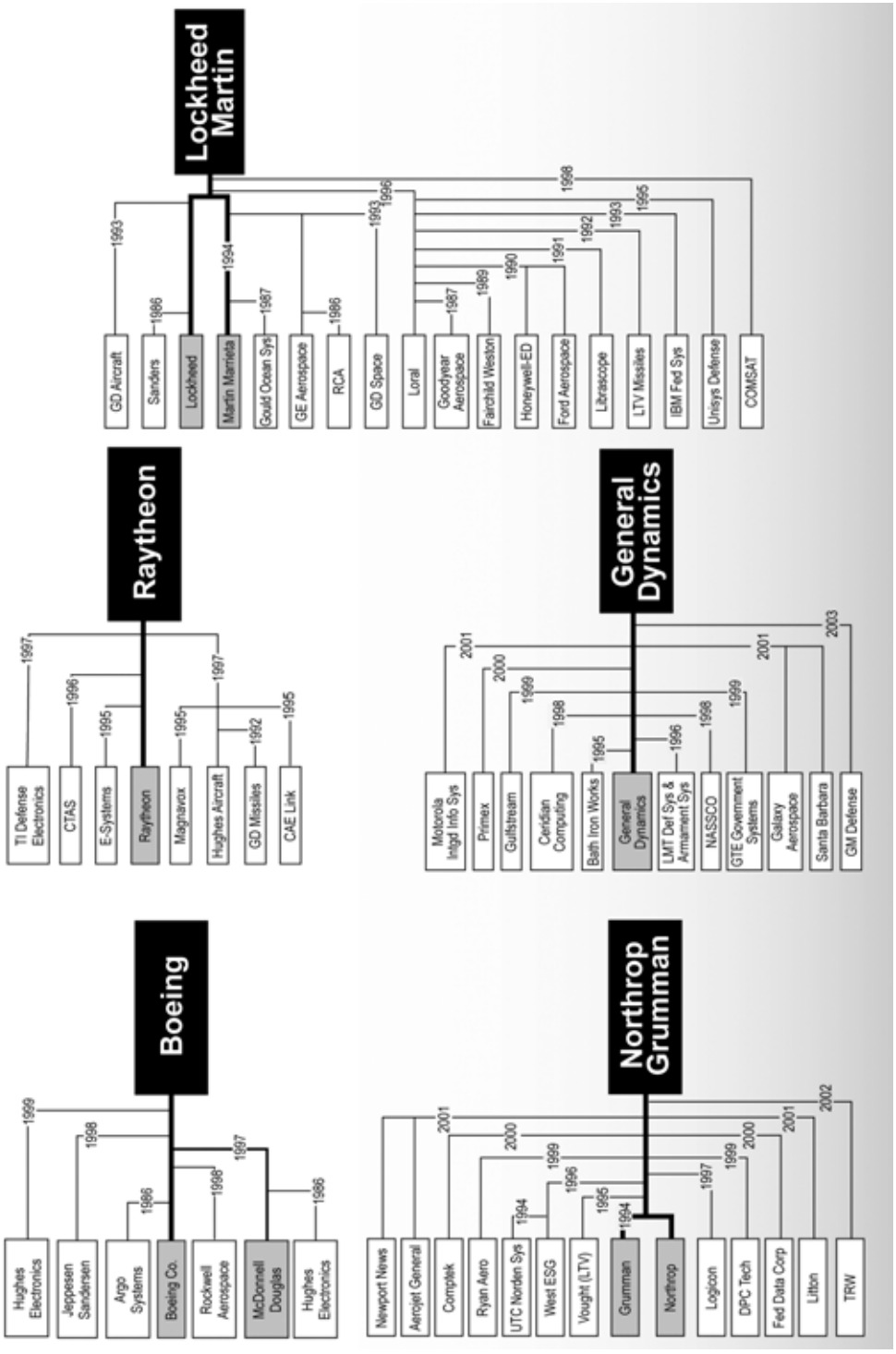

Figure 14. Narrowing the Field—the Prime Consolidation (through 2003)

A major change during the past decade has been DOD's move towards total system performance responsibility. By shifting the primary responsibility for military system definition from service system commands to industry, the government has created a procurement environment in which the business sector has an almost exclusive role in determining the best overall design and technical solution to a DOD-specified system performance requirement. That a vertically integrated prime might skew a system design analysis to favor a component or technological capability fostered by internal corporate investment should be no surprise—successful corporations are driven by the need to maximize sales and profits.

There is a companion tendency of the primes to retain program R&D funds, use them to "get smart," and develop an internal offering to justify selecting it over an outside supplier's existing offering. When such R&D funding does not trickle down to the supplier/vendor level of the industrial base, the ability to generate technology advancements for future offerings is starved and ultimately crippled. Choking off the flow of R&D dollars from the prime to the vendor base ultimately creates a self-serving result where the vendor has inadequate resources to evolve new product and the prime thus uses that as justification for deciding to "make" rather than "buy" the product.

Highly integrated "super" teams have the ability to provide DOD with much more robust systems-of-systems because of their in-house capabilities (that less integrated companies cannot possibly attempt to offer). At the same time, these beneficial characteristics could cause abuse and actually destroy part of the U.S. defense industrial base. When there is virtually unchecked authority of these super teams to decide how to source products, subsystems, and systems, the vendor base that supplies these is increasingly at risk. This vendor base shrinks because of such decisions, competition is reduced, and it is unclear that the ultimate customer is receiving best value; the best companies and products are not always offered to the government for the warfighter.

Findings

Prime consolidation has led to three challenges to developing and fielding affordable and effective war fighting equipment. The first of these is that the consolidation of prime and integrating contractors has narrowed the field and limited the competition available for DOD programs.

The second challenge, vertical integration present in the residual primes and integrators, poses an additional restraint. Competition produces the best and most affordable performance; vertical integration can stifle this vital contribution. Primes and integrators have internal incentives to select products and subsystems from divisions of their company. Such a lack of competition for products and subsystems shuts out 2nd and 3rd tier suppliers, withers the industrial base, and further strengthens the prime contractors. DOD's understanding of prime contractor make-buy choices is the critical enabler for the government to enforce its right to intervene. Many of these challenges are compounded by both flaws in requests for proposals and limitations in bidder's lists.

The third challenge arises from the short-term focus of the industrial base. For business and shareholder reasons, industry has increased its emphasis on bid and proposal to the detriment of IR&D. . And what industry does invest in IR&D tends to have a shorter-term focus—such as towards product support rather than new technology development for future products. These unsurprising circumstances are a result of shrinking DOD acquisition funding and of the DOD move to allow contractors to merge IR&D and bid and proposal in their allowable overhead. Since primes and their subcontractors, operate in a single customer market place, DOD bears a substantial portion of the responsibility to change these destructive trends

Recommendations

The core of these recommendations is focused on two principles. The first is that DOD needs to assert its responsibilities to ensure warfighter technological superiority and to understand and encourage the health of competition and innovation. The second is that industry's role is to provide best cost/value to address war fighter needs and, to

do this well, industry needs to better position its investments toward future DOD needs. Primes do have the right to compete on system products but should do so within a level playing field; that is, primes should solicit the vendor base where available and not abuse the system authorities associated with the prime role.

The intent of these recommendations is to protect the integrity of the process; foster maximum competition consistent with approved acquisition strategies; and ensure that the government receives the best value for the system, subsystem, or product procurement that is managed by the prime integrator. The existence of a formal make-or-buy policy alone, however, is insufficient unless accompanied by active oversight by the government.

To ensure that the industrial base remains vital, DOD

- stipulate that requests for proposal require primes to establish formal and open make-or-buy decision processes
- ensure full and open competition for 2nd and 3rd tier contractors by the prime and integrators
- oversee formal make-or-buy decisions
- assure the availability of alternative sources
- have the Defense Acquisition Board review make-or-buy plans for key program areas
- have the government program office actively monitor the prime after award, and approve any exceptions in formal program make/buy policy

To provide for industrial base innovation (with a view for the health of the industrial base), the government should fund competitive, alternative sources of R&D that provide

- continued innovation (in performance, cost, etc.)
- an alternative if the incumbent does not perform or allows costs to rise excessively
- a competitor for the next spiral

To encourage industry to focus on IR&D, DOD needs to fund those companies that develop innovative sources of next-generation systems or products. This incentive will focus the attention of industry on the importance of IR&D and create incentives for longer-term investment. For DOD to understand industry's investments for the longer term, it should reinstitute separate reporting for IR&D and bid and proposal (by updating the Defense Federal Acquisition Regulations). This change does not require legislation; it is simply a regulatory change within the department. As a further IR&D investment target, DOD should ask industry to set a corporate average as 3 percent of sales (comparable to the suggested DOD target of 3 percent for S&T).[18]

Incentives

Transforming technology rapidly into fielded products is a key to meeting the national security challenges of the 21st century. The security threats the nation now faces present discontinuities to established S&T processes, policies, and procedures.[19] These processes need to transform from sequential, task-based, and budget-cycle based to ones that are capable of parallel, opportunistic, and adaptive operations.

Two dimensions need to be addressed. The first is deploying proven technology to operating units in the shortest possible time. The second is dramatically shortening the time it takes for technology and weapons systems to be conceived and then become fully operational. Current acquisition processes do not emphasize these.

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18. *Report of the Defense Science Board Task Force on Defense Science and Technology Base for the 21st Century*, June 1998.

19. Peter Drucker in *The Age of Discontinuity* forecast the accelerating pace of change faced by firms in the 21st century, and those that assume continuity are likely to find keeping up with markets difficult or impossible as they are constrained by rules and mental models that no longer work. Charles Handy in the *Age of Unreason* also makes some interesting related comments. We are finding it difficult to meet the "market" needs of our warfighters vis-à-vis the threats they face in the global war on terrorism.

Acquisition policies, practices, and processes are still Cold War-based. Technology development and fielding is governed by measured, sequential events that are paced by the PPBE process that requires extensive coordination and concurrence by multiple functional communities (logistics, security, personnel, etc.). The policies and rules have been set in place to ensure, to the extent possible, "no fault" acquisition and deployment of weapon systems and technology. The need to be good stewards of the taxpayers' dollars and the national treasury is very important, but too often this mentality extends technology fielding times to points of obsolescence before fielding and fails to support the real needs of the warfighters. The intentions and spirit of current ways of transitioning technology have become dysfunctional[20] to meet the current need. In the global war on terror, this can mean lives lost and opportunities squandered while the process operates.

The panel is not asserting that the entire acquisition system requires wholesale sacking. Rather, there needs to be a faster track for moving technologies to combat units that will make a difference in battle. Furthermore, the timeframes for acquisition for major programs must be accelerated. The "clock speed" of technology transition needs to more closely match that of technology innovation and the cycle times of new and emerging multilateral threats on the current global battlefield.[21] This necessarily requires that the supporting processes, policies, and culture of DOD's technology transition and acquisition processes be transformed. A culture that values innovation, speed, agility, and prudent risk-taking must be created. But this evolution will take not just mindset and policy changes; it requires incentives.

Incentives need to be aligned with the desired outcomes. The fundamental nature of the economic relationship between the

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20 Chapter 2 of *Measuring and Managing Performance in Organizations* by Robert D. Austin presents a good discussion on how dysfunction occurs.

21 Charles Fine, in *Clock Speed: Winning Industry Control in the Age of Temporary Advantage,* discusses the varying process speeds of industries. Industries that do not recognize the "clock speeds" of the industry/market segments they are in will fail. His concepts are useful in thinking about current technology transition processes and the "market" they serve.

government and the defense industrial base, and in the context of the overall world economy, needs to be explicitly recognized and understood. This includes the monopsonist buyer and the oligopolist seller, where the pricing and market are controlled by the government-contractor relationships. These relationships have significant impact on incentives like profit and return on sales for industry. Economic incentives can drive speedy technology transition for new capabilities and improvement to in-service systems.

Recommendations

In attempting to create the proper incentives to encourage the rapid transition of technology into operational capability, the panel focused on three participants in the acquisition process. First, how can the department create the proper incentives so that industry will want to embrace the new approach? Second, why should the acquisition professionals get behind the process? Finally, what will be the benefit to the operational user who is, in the final analysis, the customer?

Industry Incentives

Multiple incentives to industry arise from spiral acquisition, as envisioned by the panel. First, if the contractor is performing well on the contract, DOD would propose that the contractor be continued for the next spiral with minimal competition. This approach takes advantage of the position on the learning curve that the contractor has achieved, which is of benefit to the government in that it doesn't start the learning curve all over with someone else. At the same time, should the contractor not be performing well, there is an advantage to other contractors to win the next spiral. This means more frequent opportunities to enter the acquisition process. The panel also believes that DOD should fund R&D of potential competitors to provide technical alternative and alternative sources.

There is also an accountability incentive for the contractor, since program managers and their team can remain associated with the contract for the entire spiral. This is not the case today where the life of the contract is much longer than a normal industry job. Should the industry perform well on a spiral, the panel recommends that the

contract provide profit incentives that are prioritized, first, on meeting schedule (getting something into the hands of the war fighter on time); second, controlling cost (so that sufficient quantities can be acquired to make a war fighting difference); and, finally, performance that is the best available for the cost and schedule. The contractor rewards on the spiral should be displayed at the contractor facility to generate pride and motivation to all employees working on the contract—and the extra rewards shared with the employees.

Government Acquisition Professionals

For the people in the government acquisition business there are also many incentives to rapid acquisition but none more important than that related to accountability. With the short acquisition cycle, it will be possible for individuals to directly be associated with program success or failure. For example, in 1998 the average ACAT I program had four program managers during its average 132-month acquisition time. If a spiral can be reduced to 60 months, it may be possible to cut that number down to 1 or 2. The short cycle times also provide an excellent opportunity for professional development, where staff members can experience all aspects of a program from development of the requirement; to design, qualification, and testing; to production and fielding. This experienced workforce would then be well-qualified for programs of greater complexity and cost. Having gone through the entire cycle, the acquisition professional will better appreciate the effects that decisions made in an early phase of the program have on later phases and operations.

Concerning operations, the panel also believes that the acquisition professionals working on a program will be in an excellent position to help in transitioning the product to the operational user by deploying with the initial operational capability, and then feeding back the lessons learned concerning product fixes or improvements that are needed on subsequent spirals or block changes. This is a benefit to both the acquisition professionals, who see their efforts more relevant, but also to the operators who see their needs more rapidly addressed. The accountability facilitated by shorter acquisition cycles, as in the contractor case, can be helped in the government case by displaying the performance that is achieved by various programs and their staffs. This

information should be used to affect promotions and future assignments. A caution, however; is that focusing on successful programs should not ignore the fact that some programs are much more challenging than others, and occasionally the best thing a program manager can do is to recommend that a program be expeditiously cancelled.

Operational User

The most important incentive for rapid acquisition is to deliver effective material into the hands of the operational user. If they do not benefit from this process, then the other benefits are irrelevant. The benefit to the user can be looked at in several ways. The first way is to determine if the process is responsive. For example, if the operational user needed something for the Cold War that doesn't show up until 15 years after the Cold War is over, and when it shows up it has obsolete technology, the system (obviously) should not be considered responsive. If a potential adversary can acquire commercial technology faster than we could acquire the same technology we should not consider our system responsive.

The fact that many DOD programs have had an average 32 percent cost growth, thereby requiring many other programs to become funding sources for the overrun, or that many operational quantities are reduced because of this cost growth, then the current acquisition system should not be considered desirable. If, after large amounts of money have been invested, a number of programs are cancelled and the warfighter receives no operational capability, the process is deficient. The fact that the nation was fortunate enough to have a Cold War adversary whose acquisition system was even worse than our own should not make us feel good.

There is a tremendous incentive to the operational user to have all of these deficiencies eliminated. The user will get operational capability sooner and more relevant to the operational conditions. The user will be able to provide feedback to change needs in future spirals more quickly, based upon operational experience. Cost overruns will be reduced, perhaps by a factor of two or three, when systems are acquired in 5 years. Previous experience has shown overruns of 32 percent for programs that are 14 years long, compared to overruns of 15 percent for program of 7 years in

length. This means that fewer systems will be delayed because of budget reductions and the quantities expected will not have to be reduced.

In general, all parties who are involved with the acquisition process will have positive incentives for rapid acquisition. Even Congress and the taxpayers who provide the DOD with their resources will see greater military capability sooner and at lower costs.

Chapter 6. Summary

Systems acquisition, as defined in the Defense Federal Acquisition Regulation and taught at the Defense Acquisition University, provides a systems engineered approach to procurement best suited to large acquisitions developed over long periods of time. While extremely logical, the system for large scale acquisition is often encumbered by late development of technologies and excessive requirements. Programs often are established without a Milestone A and arrive at Milestone B with technologies that are loosely assessed. They may not be mature enough (TRL 6) to ensure meeting the needs of Milestone C. Such disconnects may be driven by mandated requirements that can only be achieved by more risky technologies. Analysis-of-alternatives are required at present but not an analysis of the systems implications or relationships between requirements and maturation times (and costs) of individual technology solutions.

These issues were of little consequence when the time to resolve requirements and mature technologies had no direct battlefield impact. The environment and threat were relatively stable over time, so a long deliberate process could be tolerated. With the onset of the terrorist threat and insurgency operations, cracks in this system have appeared. It was clearly not responsive to the changing needs and capabilities that could be had, at least in part, and could not be extracted from the "program of record" early. This problem became obvious and was addressed incompletely even before the wars in Afghanistan and Iraq. The services, DOD, and joint agencies recognized the need for more expeditious acquisition. To meet this need, they established various and fragmented acquisition offices and programs.

Some of these ancillary approaches to acquisition provide unique and lasting capability. For example, Foreign Comparative Testing allows a mechanism for funding assessments of foreign technologies that might be of specific value to U.S. forces. Others have a specific mission focus, such as countering improvised explosive devices by the Joint Improvised Explosive Device Defeat Organization.

The military services, beginning with the Army's Rapid Equipping Force, established rapid acquisition activities in direct support of operational commands that provide an integrated approach to requirements development, technology procurement, and limited fielding. These organizations tend to leverage more mature technologies or high-risk technical approaches with significant payoff. In such an environment, program failures are well tolerated and, by staying close to the warfighter, the evolution of solutions often stays current.

Technology development efforts could be fostered through advanced concept technology demonstrations and advanced technology demonstrators. These programs focused on getting technologies in the hands of the user to determine its usefulness or to refine further development. Ostensibly, these programs would leave behind technologies with the units that participated in the studies. Subsequent sustainment and transition to a program of record would follow. However, sustainment often failed after a short period of time, and transition rarely fit any existing program, leaving a potentially valuable and proven technology languishing.

These and the many other technology development and limited fielding approaches within DOD put a significant number of capabilities in the hands of service men and women in the field much faster than would have been possible through the conventional acquisition process. However, the *ad hoc* systems suffered from redundancy, lost focus, and difficulty in sustainment.

Further, these programs have not been funded to transition technologies to programs of record, nor are budget processes conducive to rapid successes. It is well known that there is a gap in the methodology for technology transition. The same can be said of development of efforts in the laboratory systems and industry. Once a program of record exists, it is extremely difficult to rapidly insert into it new technologies or leverage material successes.

DARPA, having the responsibility to provide many defense "disruptive" technologies, is well funded, yet rarely can directly transition technologies into the field or to programs. Often their

technologies require subsequent refinement to make them sustainable and to complete all the rest of the DOTMLPF issues.

For some time, the standard system has been recognized as needing supplemental support to provide more rapid acquisition or a more appropriate process to acquire, test, evaluate, and field smaller items and systems. Many of the efforts were seen by the classic acquisition community as anemic, lacking the features of sustainment, training, integration, and other aspects of full programs. This criticism is valid, not of the individual efforts or the concept of rapid fielding, but of a partially designed and developed system. It has become nearly a mantra of both those in support of rapid acquisition and those opposed: there is no transition mechanism.

Figure 15 is an attempt to pictorially display some of these deficiencies of the current system.

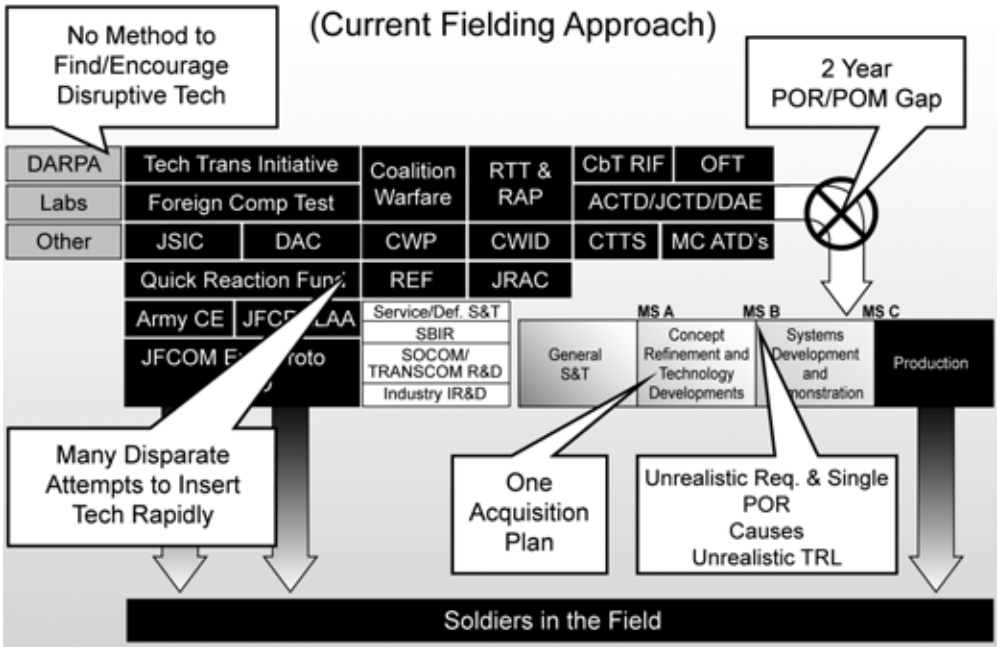


Figure 15. Current Fielding Approach

The proposal of the DSB is to first refine the implementation of the classic acquisition process so that enhancements, upgrades, and requirements are specifically planned for block 1 of the program of record. Second, distill the myriad of individual OSD rapid acquisition programs into a single organization, the Rapid Fielding Organization, with the responsibility to manage some, facilitate others, oversee service programs and enduring rapid acquisition organizations, and facilitate and fund a transition process for technologies into fielded capability. Third, establish a disruptive technology office to foster discovery of disruptive technologies most relevant to operational needs.

Two key recommendations make up the refinement of the classic acquisition process. First, mandate that a Milestone A be held. The purpose here is not to add complexity or length to the program, but rather to require a program review at a point where requirements can be balanced against an initial assessment of the maturity of the necessary technologies to fulfill the requirements. If properly assessed, the programs should arrive at Milestone B with requirements that can be met with the available technologies at TRL 6. Requirements that could not be supported with TRL 6 technologies would have to be deferred to later spirals. If, in the process of conducting the Concept Technology and Development phase, it became clear that a technology was not maturing at the pace predicted and its absence at Milestone B would imply missing a requirement, a process for relief from requirements could be conducted administratively without going through another complete JROC review. In this way, Milestone B would more likely reflect both the performance and technical aspects of the final Block 1 product.

The second key recommendation recognizes that this would likely mean deferment of capabilities until the technology matures by mandating a block development and production process for all programs. This provides several functions. First, it allows for growth in capabilities as technologies mature to meet them. Second, it offers on-ramps for innovations not previously expected. Third, it allows the requirements, resource, and acquisition communities to generate a balanced and achievable solution to program execution. However, it does require that R&D for further blocks be funded as the prior blocks are advancing.

To ensure that the Milestone A decision is best informed and that the blocking is sequenced correctly, the general S&T contribution needs to be more deliberate and thorough. Specifically, as the requirements emerge, research may need to be commissioned in order to meet a particular need. Much as is done currently, funding of specific research areas by the government labs, universities, or industry should continue. However, there are additional sources of critical technologies. Understanding not just the specific requirements but the intent of the program also allows the technical side to "prospect" for technology opportunities that may raise unforeseen but valuable capabilities that can then be codified in a requirement. Commercially or globally available technical solutions or opportunities can then be pulled into the program and impact scheduling, risk, cost, and performance. Similarly, prospecting of defense and other industry-independent R&D efforts should also be leveraged.

With such significant data on both the requirements and the maturity of the technologies likely to be used in the program, a specific analysis needs to be mandated that takes a systems view of the effort to facilitate programmatic layout and the Milestone A recommendation. This systems analysis of requirements and technologies would define the blocks showing the capabilities to be achieved in each and an assessment of cost, schedule, performance, and risk.

Modification to the classic acquisition process enables transition of technologies into programs of record. By aligning available and proven technologies with the phases of a program of record still in development, on-ramps for the technologies exist that generally do not occur today. Still, this does not define the sources of the technologies, how they are proven, or what funding source there is to transition them from their point of inception to be included in the program of record. These are the functions of the RFO.

Establishing the RFO would provide DOD with a central office responsible for the funding and facilitation of the service rapid fielding efforts and select enduring agencies doing the same but focused on specific and unique topics. The RFO is intended to replace a number of currently existing offices that, to a lesser degree, perform some similar functions. This consolidation would allow the original intent of these

programs to be continued if needed while consolidating funding and outcome. Most critical to the RFO function will be its responsibility to reserve and manage some of its funding to ensure that products that have been successfully fielded can be incorporated in the block upgrades of relevant programs or that new programs can be established quickly and with appropriate budgetary funding to follow. It is this bridging function that fills the gap not now met by any *ad hoc* or conventional approaches.

In a similar way, the Disruptive Technology Organization would be chartered to foster, search for, and implement technologies that could provide an exceptional degree of operational advantage. It would provide the key transition path for DARPA, national laboratories, academia, and industry to offer these exceptional technologies. In doing so, it would ensure sufficient maturity of the technology itself to survive in the operational environment intended, and to meet the training packages and sustainment minimums. Without this function, the technologies would likely remain unusable. Like the RFO, the Disruptive Technology Organization would have the responsibility to manage its budget in such a way as to afford transition of key technologies into programs of record and to bridge the gap caused by the two year delay in the defense budget process. This includes sustainment of equipment in the field until a program can take over its management.

The approach recommended resolves key problems with the current methodology:

- Requirements can be managed through block upgrades allowing "good enough" solutions to be fielded more quickly without compromising ultimate outcome.
- Evolving requirements stemming from an agile enemy can be responded to rapidly and incorporated in appropriate programs.
- Technology can be managed to rapidly provide "good enough" solutions without compromising the ultimate desired outcome.
- Evolving threat, environment, or technical opportunities can be accommodated in a timely manner.

- Technology insertion can be accomplished in a managed yet rapid fashion with a predictable bridging methodology.
- Funding for such activities as rapid fielding and bridging can be provided and managed.
- The large investment in the technology base can be better leveraged.
- Disruptive technologies can be pursued with a high tolerance for failure and a method of implementing significant breakthroughs.

Figure 16 illustrates this new process.

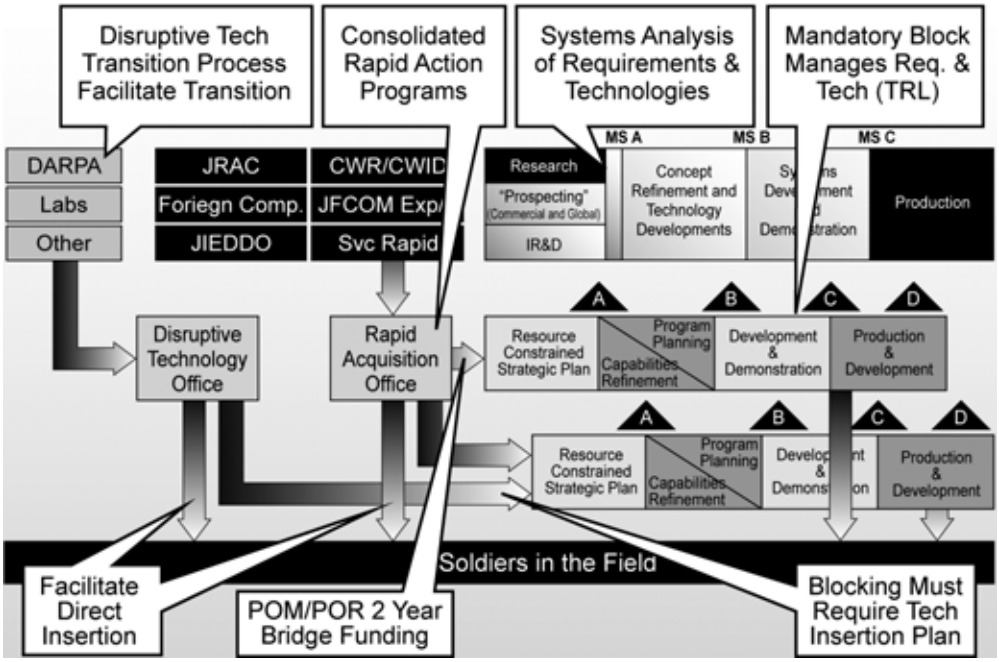


Figure 16. An Integrated Approach to Rapid Fielding

A succinct depiction of this alternative approach to acquisition is shown in Figure 17. It shows the modified formal acquisition process with its enhanced R&D functionality and systems analysis of requirements and technologies that is intended to accelerate S&T development and the execution of block spirals. This is then related to

the rapid acquisition process, disruptive demonstrations, and concurrent efforts in support of future blocks.

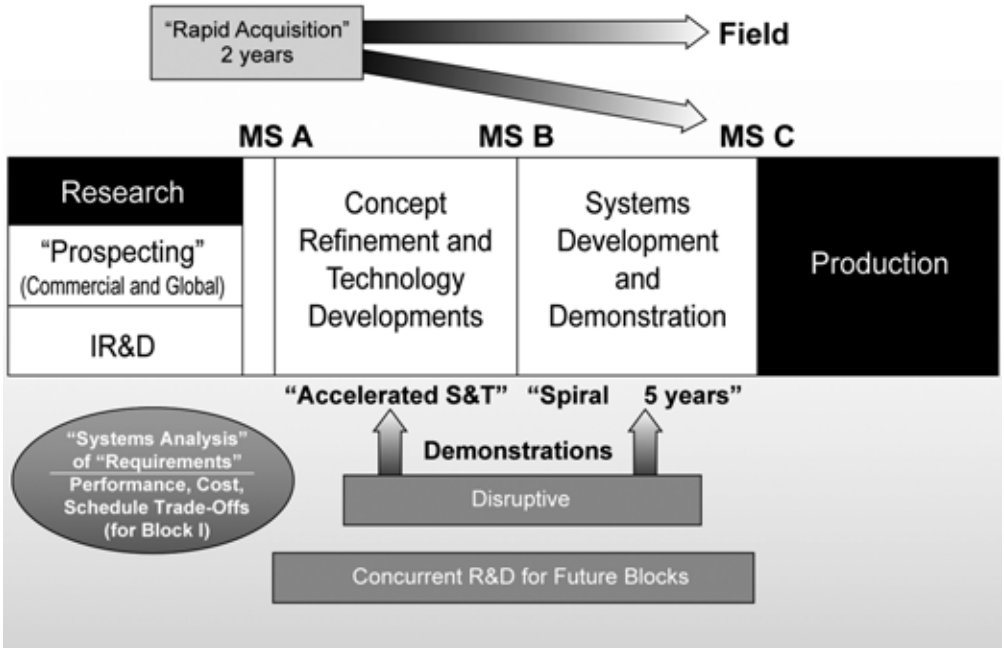


Figure 17. A New Approach to Defense Acquisition

Appendix A. Terms of Reference

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

JAN 13 2006

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference – 2006 Summer Study on 21st Century Strategic Technology Vectors

Many technology thrusts were initiated during the Cold War to support operational needs, but a few strategic capabilities proved enormously successful to enhancing U.S. combat capabilities. Stealth, speed, precision, and tactical ISR were developed to penetrate enemy battlespace with minimal losses and increase combat effectiveness. These capabilities provided the highest operational leverage, especially against State actors who chose massed force on force modes of conflict. Although hindsight easily verifies the importance of these capabilities, their implementation was uneven and problematic.

Today, adversaries (both State and non State) have moved away from massed forces to negate or mitigate U.S. combat capabilities. Denial and deception proved very effective in reducing air power effectiveness in the Kosovo air campaign. Dual use technology bestows strategic capability to small groups for relatively low investments and also allows both State and non State adversaries to economically develop effective countermeasures which lessen U.S. capabilities. The very nature of dual use technology creates significant uncertainty about any group's capabilities. Non state actors exploit seams in the international system by operating within the boundaries of sovereign states and take advantage of legal systems to plan, equip and train their forces. In effect, adversaries created operational safe havens against U.S. military capabilities.

In addition, the Department of Defense (DoD) is increasingly involved in two major mission areas of non combat operations. These include stability operations and domestic civil support missions during catastrophic natural incidents or WMD events. These mission areas stress DoD differently than combat operations and require the identification and development of new DoD capabilities.

The next generation of DoD capabilities must counter or negate safe havens and provide more effective capability in the new mission areas. Potential operational mission characteristics include:

1) US and allied freedom to operate in both State and non State's safe havens in order to deny the adversary sanctuary;
2) Ability to identify and track at suitable standoff distances, material, transactions, and items of interest across all environments;
3) Creation of sufficient situational awareness at all user levels to know when action is required and then act upon it with a high degree of effectiveness.
4) Ability to avoid substantial collateral damage and non-combatant casualties in all environments.

The Summer Study should:

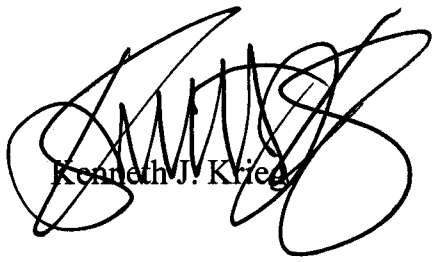
1) Review previous attempts (both successful and not) by DoD to identify critical technologies in order to derive lessons that would help illuminate the current challenge;
2) Identify the National Security objectives for the 21st century and the operational missions that U.S. military will be called upon to support these objectives;
3) Identify new operational capabilities needed for the proposed missions;
4) Identify the critical science technology, and other related enablers of the desired capabilities.
5) Assess current S&T investment plans' relevance to the needed operational capabilities and enablers and recommend needed changes to the plans;
6) Identify mechanisms to accelerate and assure the transition of technology into U'S. military capabilities.
7) Review, and recommend changes as needed, the current processes by which national security objectives and needed operational capabilities are used to develop and prioritize science, technology, and other related enablers, and how those enablers are then developed.

The Study will report its results on an interim basis to me. Its final product should provide an evaluation process by which decisions can be made and a technology roadmap to achieve the desired operational capabilities.

The study will be sponsored by me as the Under Secretary of Defense (Acquisition, Technology and Logistics), and Director, Defense Research and Engineering. Dr. Ted Gold and Dr Bill Graham will serve as the Summer Study Chairmen. Ms. Beth Foster will serve as the Executive Secretary. CDR Cliff Phillips will serve as the Defense Science Board Secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DOD Directive 5105.4, the "DoD Federal

Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.



Appendix B. Panel Membership

CHAIRMEN

Name	Affiliation
Dr. William F. Ballhaus, Jr.	Aerospace Corporation
Hon. Jacques Gansler	University of Maryland

PANEL MEMBERS

Dr. Michael Andrews	L-3 Communications
Dr. Elliot Axelband	RAND
Dr. Joseph Braddock	Private Consultant
Mr. Joe Eash	Private Consultant
Dr. Bill Howard	Private Consultant
Dr. Bruce Jette	Synovision Solutions
Mr. Donald Latham	Private Consultant
Mr. Mark Lister	Naval Research Advisory Committee
Brig Gen Robert Mansfield, USAF (Rete)	Lockheed Martin Corporation
Mr. Mark Mykityshyn	The White Oak Group, Inc.
Dr. Al Romig	Sandia National Laboratory
Dr. George Schneiter	Private Consultant
Dr. James Silk	Institute for Defense Analyses
Mr. Robert Soule	Institute for Defense Analyses
Dr. Stephen Squires	Private Consultant
Dr. Michael Yarymovych	Private Consultant

GOVERNMENT ADVISORS

Ms. Mary Margaret Evans	Office of the Deputy Under Secretary of Defense for Advanced Systems and Concepts
COL Robert Morris, USA	U.S. Joint Forces Command
Dr. Jonathon Porter	SAF/AQR
Col Mark Stephen, USAF	SAF/AQR

STAFF

Barbara Bicksler	Strategic Analysis, Inc.
Sarah Canna	Strategic Analysis, Inc.

Appendix C. Presentations to the Panel

Name	Topic
MARCH 14, 2006	
Mr. Joe Eash *Private Consultant*	Discussion of the Advanced Concepts Technology Development Process
Dr. Bruce Jette *Synovision Solutions*	Land Warrior Program Update and Transition Technology: A Case-Study-Based View
Mr. Lee Gazzano *Deputy Program Manager, REF* Mr. John Geddes *Tech Advisor, REF*	Rapid Equipping Force (REF)
APRIL 21, 2006	
Lt Gen Ron Kadish, USAF (Ret) *Chairman, Defense Acquisition Performance Assessment*	Defense Acquisition Performance Assessment
Ms. Sue Payton *Deputy Under Secretary of Defense for Advanced Systems and Concepts*	Agile Acquisition and the Technology Transition Council
Mr. Feldman *Office of Force Transformation*	Rapid Acquisition Projects in the Office of Force Transformation
Mark Lister *Chairman, Naval Research Advisory Committee (NRAC)*	NRAC Study on Technology Acquisition Reform
MAY 16, 2006	
Myron Hura, Manny Cohen, Gary McLeod and Natalie Crawford, *RAND*	Space Capabilities Development
Mr. Larry Lynn *Private Consultant; former Director, Defense Advanced Research Projects Agency*	Technology Transition
Kristen Baldwin Office of the Secretary of Defense	Integrating Requirements, Acquisition, and Programming

JUNE 7–8, 2006

Paul Francis, *GAO*	Technology Development and Transition
Bob Buhrkuhl *Office of the Secretary of Defense*	Joint Rapid Acquisition Cell

JULY 12, 2006

Beth Cole, Mark Buffler, Dave Hyman *OUSD (AT&L)/AS&C/OTT*	Independent Research and Development

AUGUST 8–11, 2006

Frank Cappuccio *Executive Vice President and General Manager, Advanced Development Programs & Strategic Planning* *Lockheed Martin Aeronautics Company*	Polecat – High Altitude UAV Technology Demonstrator
Donald G. Reinersten *Reinersten and Associates*	A Perspective on Product Development

Appendix D. Draft Memorandum and Directive for the Rapid Fielding Organization

MEMORANDUM FOR

SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
COMMANDERS OF THE COMBATANT COMMANDS
ASSISTANT SECRETARIES OF DEFENSE
GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE
DIRECTOR, OPERATIONAL TEST AND EVALUATION
INSPECTOR GENERAL OF THE DEPARTMENT OF DEFENSE
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR, ADMINISTRATION AND MANAGEMENT
DIRECTOR, PROGRAM ANALYSIS AND EVALUATION
DIRECTOR, NET ASSESSMENT
DIRECTOR, FORCE TRANSFORMATION
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: Establishment of the Rapid Field Organization (RFO)

The Global War on Terrorism is characterized by fast-adapting adversaries capable of gaining temporary operational advantage with creative tactics and technologies. Against such threats, capabilities derived from traditional, slow acquisition and development processes are inadequate. This asymmetry places a premium on anticipating threats and rapidly fielding capabilities to gain decisive technical and operational advantage. In response, the Department has initiated a variety of new programs and processes in recent years that attempt to provide timelier solutions to the new challenges we face. While much good has come from these programs and processes, they are not well integrated and thus don't provide the synergy needed to ensure unity of effort and prioritization of increasingly scare resources.

We need to better focus our efforts to provide innovative solutions that address emergent warfighting needs and customer requests for faster fielding of capabilities. We also face the ever-present challenge of funding for execution and budget-year needs inside the normal Planning, Programming, Budgeting and Executive (PPBE) cycle decision timelines. All of these things argue persuasively for a more effective way to underwrite and execute programs to rapidly meet emergent warfighter needs.

Accordingly, I am establishing the Rapid Fielding Organization (RFO) as a joint entity and jointly manned activity of the Department of Defense. The mission of the RFO is to rapidly provide capabilities necessary to facilitate the use of joint forces in military operations, or enhance the interoperability of equipment procured through other means in order to meet emergent warfighter needs. The RFO will initially be formed from a multiplicity of existing programs and report to the Secretary of Defense through the Under Secretary of Defense (Acquisition, Technology, and Logistics).

I direct the Under Secretary of Defense (Acquisition, Technology, and Logistics), to provide further detail and implementing guidance within sixty days of this memorandum. Additionally, I direct the Combatant Commands to provide a single flag-or-SES-level point of contact, with appropriate authority to commit your organization's support. I expect all other stakeholders in the Department to support and, as appropriate, to participate in this important effort.

(SecDef or DepSecDef signature)

Department of Defense

DIRECTIVE

NUMBER xxx.xx

Date

DA&M

SUBJECT: Rapid Fielding Organization (RFO)

References: (a) Title 10, United States Code

(b) Deputy Secretary of Defense Memorandum, Subject: Meeting the Immediate Warfighter Needs (IWNs), dated September 3, 2004

(c) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003

(d) CJCSI 3150.25B, "Joint Lessons Learned Program," February 15, 2004

(e) Federal Acquisition Regulation, Subpart 2.1, April 1, 1984, supplemented by Defense FAR Supplement, Subpart 202.1

(g) DoD Directive 8910.1, "Management and Control of Information Requirements," June 11, 1993

1. PURPOSE

Under the authority vested in the Secretary of Defense in reference (a), this Directive establishes the RFO as a joint entity and jointly manned activity of the Department of Defense with the mission, responsibilities, functions, relationships, and authorities as prescribed herein.

2. APPLICABILITY

This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, and the DOD Field Activities (hereafter referred to collectively as "the DOD Components"). The term "Military Departments" as used herein, refers to the Army, the Navy, the Air Force, and the Marine Corps—including National Guard and Reserve Units.

3. BACKGROUND

The Bob Stump National Defense Authorization Act for Fiscal Year 2003 (PL-107-314) Section 806 Rapid Acquisition and Deployment Procedures directed the Secretary of Defense to prescribe procedures for the rapid acquisition and deployment of items that are (1) currently under development by the Department of Defense or available from the commercial sector; and (2) urgently needed to react to an enemy threat or to respond to significant and urgent safety situations. It also directed streamlined communications between the Chairman of the Joint Chiefs of Staff, acquisition community and the research and development community in addition to streamlined testing criteria.

The Global War on Terrorism and recent experiences with Operations Iraqi Freedom and Enduring Freedom, have highlighted the institutional challenges the DOD faces in rapidly satisfying the needs of the warfighter. Establishment of the Joint Rapid Action Cell (JRAC) in 2004, reference (b), began to break down institutional barriers that prevent timely and effective warfighting support by providing and oversight mechanism to track Urgent Operational Needs and Immediate Warfighting Needs requiring timely (120 days or less) materiel or logistics solutions.

As the size and scope of military operations grew, it became apparent that not only was there a requirement to monitor and champion immediate warfighting needs but there was also a need for a process that would address urgent operational needs. Such needs are more complex in nature but have the potential to better protect fighting forces and quickly yield the technological edge against the enemy.

4. MISSION

The RFO shall rapidly provide capabilities necessary to facilitate the use of joint forces in military operations, or enhance the interoperability of equipment procured through other means in order to meet urgent operational needs.

5. ORGANIZATION AND MANAGEMENT

RFO is established as a joint entity and jointly manned activity of the Department of Defense under the direction, authority, and control of the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)). RFO shall consist of a Director and such subordinate elements as are established by the Director within resources authorized by the Secretary of Defense.

6. RESPONSIBILITIES AND FUNCTIONS

The Director, RFO, shall:

6.1. Organize, direct, and manage the RFO and all assigned resources.

6.2. Serve as the DOD point of coordination and catalyst for initiatives across the full range of efforts to rapidly provide capabilities necessary to facilitate the use of joint forces in military operations, or enhance the interoperability of equipment procured through other means in order to meet emergent warfighter needs.

6.3. Provide guidance and assistance, as appropriate, to the DOD Components and other U.S. Government activities on matters pertaining to the projects assigned to RFO.

6.4. Recommend to the appropriate decision bodies in DOD, through the AT&L, projects that have the potential to replace or enhance existing or emerging Programs of Record covered by reference (c).

6.5. Arrange for the performance of, and supervise, RFO projects assigned to the Military Departments, other U.S. Government activities, individuals, private business entities, educational institutions, or research institutions, giving consideration to the primary functions of the Military Departments.

6.6. Engage in projects to determine technology investment priorities taking into consideration both military needs and commercial potential. Long-term strategies should promote better integration of the military and civilian industrial base.

6.7. Conduct demonstration projects that embody concepts of operation and technology appropriate for joint programs, programs in support of deployed forces, or selected programs of the Military Departments and, on request, assist the Military Departments in their prototyping programs.

6.8. Keep the AT&L and the DOD Components informed, as appropriate, on significant new developments, breakthroughs, and technological advances within assigned projects and on the status of such projects to facilitate early operational assignment.

6.9. Prepare and submit to the Comptroller of the Department of Defense, in accordance with established procedures, the RFO's annual program budget estimates, to include the assignment of appropriation program priorities.

6.10 Coordinate with the Joint Staff through access to the Joint Lessons Learned Database covered by reference (d) to ensure that Joint needs are satisfied to the maximum extent possible.

6.11. Perform such other functions as may be assigned by the AT&L.

7. AUTHORITY

The Director, RFO, is specifically delegated authority to:

7.1. Place funded work orders with organizations of the Military Departments, other DOD Components, or other organizations of the Federal Government.

7.2. Authorize the allocation, as appropriate, of funds made available to RFO for assigned projects.

7.3. Establish for RFO, the Military Departments, and other activities, procedures required in connection with work being performed for RFO, consistent with policies and instructions governing the Department of Defense.

7.4. Serve as Head of an Agency and Contracting Activity within the meaning of, and subject to the limitations of, FAR 2.1, as supplemented by DFARS, Subpart 202.1 (reference (e)).

7.5. Prosecute assigned projects by contract, grant, cooperative agreement, or any other authorized means.

7.6. Acquire or construct, directly or through a Military Department or other U.S. Government Agency, such research, development, and test facilities and equipment required to carry out assignments that may be approved by the Secretary of Defense in accordance with applicable statutes and DOD Directives.

7.7. Obtain reports and information, consistent with the policies and criteria of DOD Directive 8910.1 (reference (f)), and advice and assistance from other DOD Components, as necessary, to carry out RFO functions and responsibilities.

7.8. Communicate directly with the DOD Components, other Executive Departments and Agencies, foreign research activities, and non-DOD R&D activities, as appropriate. Communications to the Commanders of the Combatant Commands shall be transmitted through the Chairman of the Joint Chiefs of Staff.

7.9. Exercise the administrative authorities in enclosure 1.

8. RELATIONSHIPS

8.1. The USD(AT&L) shall exercise authority, direction, and control over the Director, RFO.

8.2. The Director, RFO, shall:

8.2.1. Ensure that the appropriate DOD Components are kept fully informed concerning RFO activities with which they have substantive concern.

8.2.2. Make appropriate use of established facilities and services in the Department of Defense or other Governmental Agencies, wherever practicable, to achieve maximum efficiency and economy.

8.3. The Secretaries of the Military Departments and the Heads of other DOD Components shall:

8.3.1. Provide assistance and support, in their respective fields of responsibility and within available resources, to the Director, RFO, as may be necessary to carry out the responsibilities and functions assigned to RFO.

8.3.2. Coordinate with the Director, RFO, on all matters related to responsibilities and functions assigned to RFO.

8.3.3. Direct subordinate elements to follow the procedures established pursuant to paragraph 6.3., above.

9. ADMINISTRATION

9.1. The Director, RFO, shall be a civilian selected by the Secretary of Defense based on recommendations by the USD(AT&L).

9.2. RFO shall be authorized such personnel, facilities, funds, and other administrative support as the Secretary of Defense deems necessary.

9.3. The Military Departments shall assign personnel to RFO in accordance with approved authorizations and procedures for assignment to joint duty.

9.4. Administrative support shall be provided by one, or more, of the DOD Components, as appropriate.

10. EFFECTIVE DATE

This Directive is effective immediately.

Enclosures - 1

E1. ENCLOSURE 1

DELEGATIONS OF AUTHORITY

E1.1.1. Pursuant to the authority vested in the Secretary of Defense, and subject to the authority, direction, and control of the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology and Logistics and in accordance with DOD policies, Directives, and Instructions, the Director, RFO, or in the absence of the Director, the person acting for the Director, is

hereby delegated authority as required in the administration and operation of RFO to:

E1.1.1.1. Establish advisory committees and employ temporary or intermittent experts or consultants, as approved by the Secretary of Defense, for the performance of RFO functions consistent with 10 U.S.C. 173; 5 U.S.C. 3109(b); and DOD Directive 5105.4, "DOD Federal Advisory Committee Management Program," September 5, 1989.

E1.1.1.2. In accordance with 5 U.S.C. 7532; Executive Orders 10450, 12333, and 12356; and DOD Directive 5200.2, "DOD Personnel Security Program," May 6, 1992; as appropriate:

E1.1.1.2.1. Designate any position in the RFO as a "sensitive" position.

E1.1.1.2.2. Authorize, in case of an emergency, the appointment of a person to a sensitive position in the RFO for a limited period of time and for whom a full field investigation or other appropriate investigation, including the National Agency Check, has not been completed.

E1.1.1.2.3. Initiate personnel security investigations and, if necessary in the interest of national security, suspend clearance for personnel assigned, detailed to, or employed by RFO. Any action under this paragraph shall be taken in accordance with procedures prescribed in DOD 5200.2-R, "Department of Defense Personnel Security Program," January 1987.

E1.1.1.3. Authorize and approve:

E1.1.1.3.1. Temporary duty travel for military personnel assigned or detailed to the RFO in accordance with Joint Federal Travel Regulations, Volume 1, "Uniformed Service Members."

E1.1.1.3.2. Travel for RFO civilian employees in accordance with Joint Travel Regulations, Volume 2, "DOD Civilian Personnel."

E1.1.1.3.3. Invitational travel to non-DOD personnel whose consultative, advisory, or other highly specialized technical services are required in a capacity that is directly related to, or in connection with, RFO activities, in

accordance with Joint Travel Regulations, Volume 2, "DOD Civilian Personnel."

E1.1.1.3.4. Overtime work for RFO civilian employees in accordance with Chapter 55, Subpart V, of 5 U.S.C. and applicable Office of Personnel Management regulations.

E1.1.1.4. Approve the expenditure of funds available for travel by military personnel assigned or detailed to the RFO for expenses incident to attendance at meetings of technical, scientific, professional, or other similar organizations in such instances where the approval of the Secretary of Defense, or designee, is required by 37 U.S.C. 412, and 5 U.S.C. 4110 and 4111.

E1.1.1.5. Develop, establish, and maintain an active and continuing Records Management Program pursuant to 44 U.S.C. 3102 and DOD Directive 5015.2, "Records Management Program," March 22, 1991.

E1.1.1.6. Establish and use imprest funds for making small purchases of material and services, other than personal services, for the RFO, when it is determined more advantageous and consistent with the best interests of the Government, in accordance with DOD Directive 7360.10, "Disbursing Policies," January 17, 1989.

E1.1.1.7. Authorize the publication of advertisements, notices, or proposals in newspapers, magazines, or other public periodicals as required for the effective administration and operation of the RFO, consistent with 44 U.S.C. 3702.

E1.1.1.8. Establish and maintain, for the functions assigned, an appropriate publications system for the promulgation of common supply and Service regulations, instructions, and reference documents, and changes thereto, pursuant to the policies and procedures prescribed in DOD 5025.1-M, "DOD Directives System Procedures," August 1994.

E1.1.1.9. Enter into support and service agreements with the Military Departments, other DOD Components, or other Government Agencies, as required, for the effective performance of RFO functions and responsibilities.

E1.1.1.10. Enter into and administer contracts, directly or through a Military Department, a DOD contract administration services component, or

other Federal Agency, as appropriate, for supplies, equipment, and services required to accomplish the mission of the RFO. To the extent that any law or Executive order specifically limits the exercise of such authority to persons at the Secretarial level of a Military Department, such authority shall be exercised by the appropriate Under Secretary or Assistant Secretary of Defense.

E1.1.1.11. Exercise the authority delegated to the Secretary of Defense by the Administrator of General Services on the disposal of surplus personal property.

E1.1.1.12. Exercise the authority of the Head of an Agency pursuant to Chapter 137 of 10 U.S.C.

E1.1.1.13. Enter into and administer grants, cooperative agreements, and other authorized transactions with any Agency, university, nonprofit corporation, or other organization to carry out or support work required to execute any assigned advanced research project, and establish procedures for RFO to carry out all the authorities and responsibilities contained in 10 U.S.C. 2358 and 2371.

E1.1.1.14. Promulgate the necessary security regulations for the protection of property and places under the jurisdiction of the Director, RFO, pursuant to DOD Directive 5200.8, "Security of DOD Installations and Resources," April 25, 1991.

E1.1.1.15. Establish and maintain appropriate property accounts for RFO and appoint Boards of Survey, approve reports of survey, relieve personal liability, and drop accountability for RFO property contained in the authorized property accounts that has been lost, damaged, stolen, destroyed, or otherwise rendered unserviceable, in accordance with applicable laws and regulations.

E1.1.2. The Director, RFO, may redelegate these authorities as appropriate, and in writing, except as otherwise specifically indicated above or as otherwise provided by law or regulation.

Appendix E. Rapid Acquisition Programs

The accelerated pace of global technology development challenges the DOD's ability to quickly respond to ever-changing, asymmetric threats. Transformation and QDR goals continue to stress an emphasis on rapidly developing and fielding new innovative and transformational technology and operational concepts. There are a number of programs currently in the DOD designed to meet these challenges, and these programs, by and large, can be described as falling into one of two acquisition categories: rapid and agile. These programs are in contrast to the traditional acquisition process that is directly linked to a formal, two year PPBE process. In contrast, the rapid and agile programs involve projects that are purposely resourced inside the PPBE process.

Rapid acquisition programs focus on urgent operational needs with an emphasis on meeting initial materiel or logistics solutions in 120 days or less. Rapid acquisition programs focus almost exclusively on procuring off-the-shelf technologies. It could be debated that these are, in reality, rapid "procurement" programs since material solutions are usually already known and all that is required is a procurement decision. The military services and the Joint Staff have a number of processes in place to address urgent operational needs requiring a procurement decision, and are the departmental focal point for this requirement. Yet these activities report to many organizations, as shown in Figure E-1.

Agile acquisition programs are often thought of as "applied technology" programs; they require little development or advancement of state-of-the-art. The key challenge in agile acquisition programs is to integrate technologies, components, or subsystems to produce a new capability in three years or less.

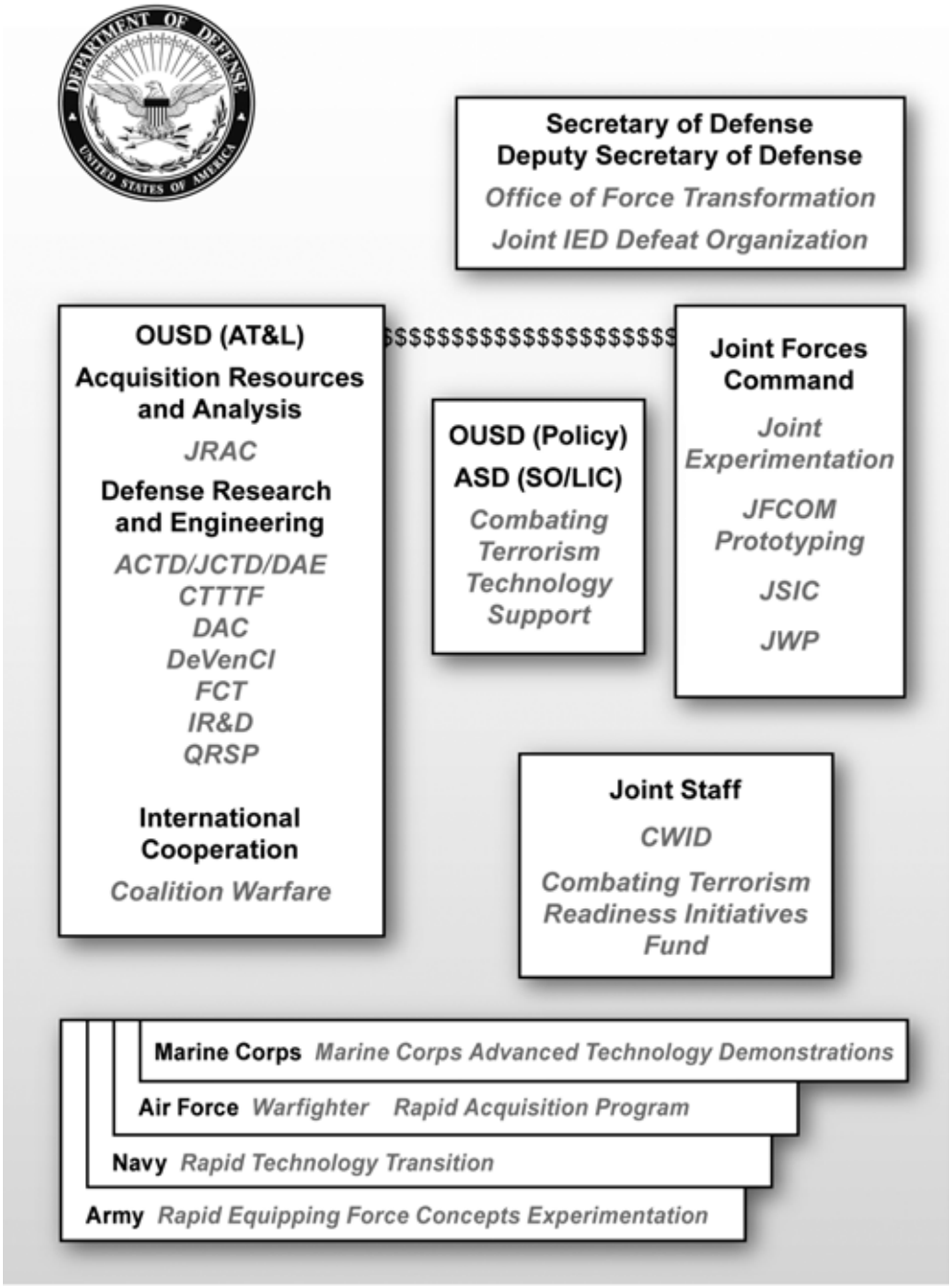


Figure E-1. Rapid Acquisition Programs in DOD

What follows are examples of DOD programs currently in place to rapidly transition technology into acquisition or procurement pathways, thus increasing capability for the warfighter. Viewed collectively, as shown in Figure E-2, just these example programs total more than $2.9 billion in fiscal year 2006, include multiple appropriations, and cross the spectrum of technology and manufacturing readiness levels. Not included in this listing are agile acquisition efforts in the service S&T laboratories, or the defense agencies (such as DARPA, the Defense Threat Reduction Agency, or the Defense Information Systems Agency). The combatant commanders are also not included, though they significantly influence the rapid and agile programs. Likewise, the Small Business Innovative Research (SBIR) program is not included, although many have argued that it could be more effectively used to rapidly transition technology into capability for the warfighter.

Programs	BA	FY-05	FY-06	FY-07
ACTD/JCTD/DAE Programs:		**$ 207,818**	**$ 213,592**	**$ 206,949**
Advanced Concept Technology Demo (ACTD)	3	$ 207,818	$ 170,275	$ 158,334
Joint Concept Technology Demo (JCTD)	3		$ 34,443	$ 35,553
JCTD: (Transition):	4		$ 6,889	$ 3,047
Defense Acq Executive:	5		$ 985	$ 6,015
OSD Major Equip (JCTD):	P-1		$ 1,000	$ 2,000
JCTD O&M (USJFCOM)				$ 2,000
Coalition Warfare	4	$ 5,643	$ 5,685	$ 5,878
Coalition Warrior Interop Demo (C4I for the Warrior)	7	$ 1,563	$ 1,342	$ 1,353
Combatting Terrorism Readiness Initiative Fund		$ 47,633	$ 49,103	$ 52,328
Concepts Experimentation	6	$ 20,866	$ 38,496	$ 21,626
Combatting Terrorism Technology Support	3	$ 116,717	$ 143,949	$ 65,768
Defense Acquisition Challenge (DAC)	5	$ 24,727	$ 33,533	$ 29,500
DeVenCI [1]		$ -	$ -	$ -
Foreign Comparative Testing (FCT):	6	$ 36,268	$ 37,260	$ 31,995
Independent Research & Development		$ -	$ -	$ -
Joint Experimentation (JE)*	3	$ 168,195	$ 180,106	$ 115,684
Joint IED Defeat Organization [2]			$ 1,958,089	$ 2,100,000
Joint Rapid Acquisition Cell [3]		$ -		
Joint Systems Integration Cmd (JSIC)*	4	$ 21,717	$ 23,032	$ 20,755
Joint Warfighting Program (JWP)	3	$ 10,376	$ 10,043	$ 10,641
Marine Corps Advanced Technology Demos	3	$ 48,140	$ 20,449	$ 24,088
Office of Force Transformation	6	$ 37,645	$ 60,448	$ 20,404
QRSP Total: (DDR&E OPR)	3	**$ 127,268**	**$ 108,942**	**$ 107,782**
Quick Reaction Fund	3	$ 35,255	$ 29,241	$ 28,728
Tech Transition Initiative (TTI)	3	$ 20,316	$ 29,241	$ 28,728
Rapid Reaction Fund	3	$ 71,697	$ 50,460	$ 50,326
Rapid Equipping Soldier Support Equipment	P	$ 196,700	$ 54,200	$ 50,700
Rapid Technology Transition (RTT)	7	$ 19,516	$ 25,266	$ 39,285
Warfighter Rapid Acquisition Program	7	$ 34,697	$ 22,764	$ 30,584
(Source: PRB 2007 dated Feb 2007)	**TOTAL**	**$ 1,125,489**	**$ 2,986,299**	**$ 2,935,320**

Figure E-2. Examples of Current Rapid Acquisition Programs

Examples of Rapid and Agile Acquisition Programs

Technology Demonstration Programs. The Advanced Concept Technology Demonstration (ACTD) Program, started in 1995, allows the warfighter to evaluate a technology's military utility in a new or vetted operational concept of employment before committing to a major acquisition effort—a "try before you buy" and "80 percent solution" methodology. As of fiscal year 2005, 154 ACTD and Joint Capability Technology Demonstrations (JCTD) have been initiated. Approximately 54 of these have provided capabilities that our troops are using today in direct support of Operation Iraqi Freedom (OIF). Overall, more than 70 percent of the ACTDs initiated to date have transitioned at least one product to the warfighter.

Despite the agile and innovative nature of ACTDs, an improved business model, the JCTD program, was initiated in fiscal year 2006 that will replace the ACTD program over the next few years. The JCTD model will improve on the ACTD design by reducing development time by at least one year with 80% transitioning at least 50% of their products to sustainment. The JCTD business model will be linked closer to combatant commander needs, with the goal of providing a spiral capability within a year and the potential for transition funding if the capability proves to have significant military utility. JCTDs address GAO, congressional, and QDR direction to quickly respond to combatant commander and asymmetric/joint warfare capability gaps—a "demand-driven" process.

The new model will accelerate agility, innovation, customer focus, and oversight for transition of joint, coalition, interagency, and transformational capabilities. Closely associated with the JCTD business model is the Defense Acquisition Executive (DAE) pilot program. This pilot program aims at taking a very few "joint peculiar" ACTD or JCTDs that are providing a significant residual capability but are not yet in a service program of record. The DAE pilot will provide a horizontal bridge across services until an appropriate program of record can be established via an executive agent who may not have the resources available to fund the integration of a particularly "joint" initiative. Combined, the JCTD and DAE pilot program create a "cradle-to-

grave" approach for the most critical "joint peculiar" capabilities that require a horizontal integration across the services.

Coalition Warfare. Coalition Warfare is a defense-wide effort to assist the combatant commander, services, and defense agencies in integrating coalition-enabling solutions into existing and planned U.S. programs. The program focuses not only on short-term, interoperability-enhancing solutions, but also on early identification of coalition solutions to long-term interoperability issues (architectures, coalition requirements, major system acquisition) with a broad range of potential coalition partners. Coalition Warfare provides the Office of Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD (AT&L)) with the ability to initiate projects in prioritized capability areas determined by the USD (AT&L) and his counterparts.

Coalition Warfare projects are selected for their emphases on warfighter solutions that offer combatant commanders the capabilities they demand, such as coalition tactical communications; coalition intelligence, surveillance, and reconnaissance; coalition combat identification; and coalition logistics. In addition, the program considers candidate projects for their portability and ability to be fielded in developing solutions that are applicable to multiple combatant commands and reach warfighters quickly. Lastly, to conserve funds and maximize the benefit to the U.S. government, the program aims to support projects that leverage financial contributions, man-hours, technology, infrastructure, and prior investment of both foreign and other DOD partners.

Coalition Warrior Interoperability Demonstration (CWID). The CWID is the annual event by the Chairman of the Joint Chiefs of Staff that enables U.S. combatant commanders and the international community to investigate new and emerging technologies that can be moved into operational use within 6–12 months following the execution period. The demonstration builds a temporary global network over which cutting edge communications technologies interact to support scripted scenarios. Technologies are evaluated for utility, interoperability with existing and new systems, and security. CWID traces its history to the establishment of the Secure Tactical Data Network series originated by the U.S. Army in 1994 to demonstrate

emerging command, control, communications, and computer capabilities.

Combating Terrorism Readiness Initiatives Fund (CbT RIF). The CbT RIF selects and funds technologically sound solutions for physical security equipment and site improvements to prevent terrorists from gaining access to, and causing mass casualties at, the combatant commands. Physical security equipment includes such things as personnel mass notification systems, surveillance systems, lighting, access control, and body armor. Examples of physical security site improvements include minor construction of perimeter and entrance fences, barriers, and gates. CbT RIF initiatives are not intended to subsidize ongoing projects, supplement budget shortfalls, or support routine service responsibility activity. CbT RIF funds are strictly O&M and procurement, and do not include research and development.

Combating Terrorism Technology Task Force (CTTTF). The CTTTF was created in September 2001 to provide a forum to bring DOD, laboratories, and various agencies together to focus on technology solutions addressing the global war on terrorism. The Department does not have a specific funding line for CTTTF, however resources from the Quick Reaction Special Project (QRSP) line have been used to accelerate development and fielding of transformational technologies (see QRSP description below). CTTTF has gone through four phases:

- **Phase I** (Sep 2001 to Feb 2002). CTTTF actions dealt with the immediate post-9/11 events leading up to and including Operation Enduring Freedom (OEF) in Afghanistan. DDR&E quickly assembled experts across the department, the defense agencies, and Joint Staff to identify technology opportunities covering the full spectrum of combating terrorism requirements from prevention to protection.
- **Phase II** (May 2002 to May 2003). CTTTF actions directly supported preparation and the deployment of advanced technologies for OIF. The key DDR&E objective was to address anticipated technological needs and develop near-term capabilities for the combatant commanders, with a focus on fielding prototype units within six months. CTTTF operations

were modified to focus on operational capabilities for the Central Command (CENTCOM) and Special Operations Command (SOCOM).

- **Phase III** (May 2003 to Dec 2005). Initiatives focused on operator-requested assistance to improve force protection capabilities. While specific programs are classified, actions are underway to "stop the bleeding" stemming from terrorist use of weapons such as IEDs, mortars, and rocket-propelled grenades. Key focus is on the detection and defeat of IEDs, with predictive analysis capabilities to attack enemy leadership and infrastructure.
- **Phase IV** (Dec 2005 – present). "The long war" outlined in the QDR has acknowledged the need for a long-term commitment to countering international terrorism. CTTTF is now addressing the global threat across a broad range of focus areas.

Concepts Experimentation (CE). The CE effort is a key innovative tool that provides the Army with the ability to capitalize on emerging technologies, emerging warfighting concepts, and new materiel initiatives. Executed by the Training and Doctrine Command (TRADOC) Futures Center, CE efforts fund concept development through experimentation and exercises that are critical to the success of the Army's unit of action IOC. CE is an analytically designed, integrated, and synchronized program of small- through large-scale experimentation using multiple live, virtual, and constructive venues to efficiently provide validation and quantifiable data supporting the development of required capabilities across the domains of DOTMLPF. The Army uses experimentation as the central focus to refine and mature warfighting concepts, and identify and validate critical decisions related to concept-based required DOTMLPF capabilities.

As capability gaps identified by deployed forces reveal shortfalls that impact effectiveness or interoperability, and these capability gaps are prioritized by the Army, the CE program provides the ability for the Army to evaluate high-priority/high-leverage solutions from industry during the current year, with highest priority going to candidates that cover multiple capability gaps. Funding provides the ability to identify and insert leading-edge technology from industry to deployed forces in

an incremental manner by leveraging the best ideas of best-positioned program manager/program executive officers and pulling or spiraling them forward for immediate use in the theater.

Combating Terrorism Technology Support (CTTS). The CTTS program develops technology and prototype equipment to address needs and requirements with direct operational application in the national effort to combat terrorism. Projects are distributed among a number of mission categories: Joint Improvised Explosive Device Defeat; Blast Defeat: Infrastructure Protection; Investigative Support and Forensics; Physical Security; Training Technology Development; Special Projects; Surveillance, Collections, and Operations Support; Tactical Operations Support; and VIP Protection. This program is a non-system, advanced technology development effort that demonstrates the utility or cost reduction potential of technology when applied to combating terrorism requirements. It includes technology development and proof-of-principle demonstrations in field applications and coordination to transition from development to operational use.

Defense Acquisition Challenge (DAC). The DAC program is the "on ramp" for business' (regardless of size) to challenge a system currently in the acquisition cycle. DAC funds are used to test and evaluate mature technologies or commercial products, with the potential to accelerate insertion and influence the technology transition inside the budget cycle by:

- introducing innovative technologies and products into DOD acquisition programs
- enabling any person or activity to propose alternatives, known as "challenge proposals," that improve the performance, affordability, manufacturability, or operational capability of an acquisition program
- providing an "on-ramp" for small- and mid-sized businesses into the DOD acquisition process and a competitive path into DOD programs of record.

Authorized by title 10, United States Code, section 2359(b), DAC was established in fiscal year 2003 as a five-year pilot program and one of three sub-elements under the QRSPs. Congress directed transfer to a

separate 6.5 Program Element in FY 2005 to refocus the program on more mature technologies. Response from U.S. vendors/industry and DOD acquisition programs has been exceptional. Since 2003, over 1,300 proposals have been submitted by industry and government, of which 274 were endorsed by programs of record, and 63 have been selected for funding, totaling approximately $93 million. Other points of interest:

- From fiscal years 2003 to 2005, 70 percent of the projects awarded went to U.S. small and medium enterprises.
- DAC enables entry of non-traditional defense industry into DOD acquisition.
- Ten DAC projects have yielded equipment currently in use today in support of the global war on terrorism.

Defense Venture Catalyst Initiative (DeVenCI). DeVenCI is a program being proposed as a POM-08 initiative; planning activities in fiscal years 2005 and 2006 have been funded out of QRSP. The objectives of this program will be to speed DOD adoption of promising new commercial technologies, and to encourage broader commercial support of the DOD supply chain. DeVenCI will use workshops, technical expositions, industry outreach, and a web portal to increase the visibility of DOD needs to commercial companies and technology area experts. It will also provide timely information to DOD users about emerging technical innovations and opportunities. DeVenCI will be a catalyst initiative that does not fund the development of new technologies or businesses, but rather focuses on knowledge brokering by encouraging and facilitating information sharing to speed emerging solutions to DOD user needs.

The core program is responsible for tracking the full range of technology areas relevant to the DOD, but over time it will spin off technology sector initiatives that will focus on specific areas such as information technology, biotechnology, energy, materials and nanotechnology, and space. The goal of each technology sector initiative will be to move oversight of that area closer to a DOD customer with a strong interest in the area.

The first such technology sector initiative is proposed to be in information technology, which will be overseen by the Assistant Secretary of Defense for Networks and Information Integration/ Department of Defense Chief Information Officer (ASD [NII]/DOD CIO). The information technology sector will identify and speed the transfer of information technologies that move the DOD towards a network-centered model of warfighting and improve support for the DOD's Global Information Grid.

Foreign Comparative Testing (FCT). The FCT program grew out of the Foreign Weapons Evaluation Program started in 1980. In 1989, the Congress created FCT under 10 U.S.C. 2350a (g). FCT funds the test and evaluation of mature equipment and technologies developed by allied and coalition partners to satisfy U.S. defense requirements, thereby:

- accelerating the acquisition process and reducing development costs (avoiding new starts)
- enabling transition within the budget cycle by testing and insertion within six months to two years
- enhancing interoperability with coalition partners, strengthening defense relationships and armaments cooperation, and serving as a catalyst for partnering between domestic and overseas defense industries.

Since 1980, 26 coalition partners have teamed with U.S. industry in 31 states. The transition rate, from testing to procurement to fielded products, is 80 percent over the past five years.

Independent Research and Development. Major defense contractors spend about $3 billion annually on IR&D activities. R&D is considered a cost of doing business, and defense contractors are allowed to recover a portion of their IR&D expenses as an indirect expense on contracts subject to cost accounting standards. On average, defense contractors recover about half of their IR&D expenses. Summaries of contractor IR&D projects are voluntarily submitted to DOD and included in the IR&D database. Changes to IR&D law in the early 1990s caused a significant change in DOD's visibility of contractor IR&D. Prior to these changes, major defense contractors were required to submit IR&D plans for DOD review and approval,

and ceilings were established on the amount of IR&D costs each contractor could recover as indirect expenses under Defense contracts. The current IR&D law, enacted in 1991, phased out the DOD approval requirement and the reimbursement ceilings. While applauding these changes, contractors have expressed concerns about decreased feedback on their IR&D activities, and there is a perception that IR&D summaries are an under-utilized resource.

IR&D includes: basic research, applied research, development, and systems/concept formulation studies. DOD policy encourages contractors to undertake IR&D activities that may further national security in a broad sense, may lead to a superior military capability, or may lower the cost and time required for providing that capability. DOD components are required to consider the work and accomplishments of contractor IR&D programs when planning, programming, and budgeting for DOD-funded R&D. Policy on IR&D can be found in 10 USC § 2372 and DODD 3204.1.

Joint Experimentation. The Chairman, Joint Chiefs of Staff designated USJFCOM "as the Executive Agent for conducting joint warfighting concept development and experimentation within the Department of Defense." The Secretary of Defense signed the USJFCOM's Joint Warfighting Experimentation Charter on May 15, 1998. Coordinated experimentation effort is an indispensable supporter of transformational objectives and is critical to improving DOD military capabilities in the "long war" against terrorism. Development of advanced techniques, tools, and organizations through the Joint Experimentation Program ensures the effectiveness of the future joint force. Input for conceptual and prototypical ideas for experimentation come directly from the combatant commanders and services. USJFCOM conducts internal analyses to determine best areas for joint experimentation investment. joint experimentation has the potential to provide exceptional return on investment in areas including joint operational concept development, joint training, S&T, acquisition validation, and test and evaluation.

Joint Improvised Explosive Device Defeat Organization (JIEDDO). Established as a task force in the fall of 2003, JIEDDO's mission is to focus (lead, advocate, coordinate) all DOD actions in

support of the combatant commanders and their respective efforts to defeat IEDs as weapons of strategic influence. The JIEDDO is a joint entity operating under the authority, direction, and control of the Deputy Secretary of Defense.

JIEDDO efforts include serving as the DOD point of coordination and catalyst for initiatives across the full range of efforts necessary to defeat the IED threat; integrating all IED defeat solutions throughout the DOD, seeking interagency assistance as necessary, and identifying innovative near-term solutions; developing transition plans for proven joint IED defeat initiatives into DOD programs of record for sustainment and further integration; and rapidly acquiring and fielding equipment. In addition, the JIEDDO coordinates with the DOD components to develop, publish, and update the DOD IED Defeat Strategic Plan which provides an overarching framework to guide the DOD components' long-term counter-IED efforts.

Joint Rapid Acquisition Cell (JRAC). To overcome institutional challenges in quickly satisfying warfighters' urgent needs, the Deputy Secretary of Defense directed the USD (AT&L), and the USD, Comptroller, to establish the JRAC as a single point of contact within the DOD for meeting immediate warfighter needs. In January 2005, the Secretary of Defense also designated the JRAC as the DOD focal point for coordination of rapid acquisition authority (RAA) for which the Secretary of Defense make a written determination to implement the authorities granted in Title VIII of the Ronald W. Reagan National Defense Authorization Act of 2005.

The JRAC tracks the resolution and timeliness of actions on IWNs, and provides regular reports to the Deputy Secretary of Defense, the USD (AT&L) and the USD (C). The JRAC process supplements the rapid needs validation and resourcing processes of the military services—it does not replace them. The JRAC focuses on resolving immediate warfighter needs within 120 days. Some solutions may take longer, but will likely be far quicker than normal budgeting and acquisition processes. The JRAC receives, coordinates, makes recommendations, and tracks the progress of rapid acquisition authority determinations for the Secretary of Defense. These determinations may waive any provision of law, policy, directive or regulation (short of

criminal statutes) to procure materiel solutions when a combat deficiency has resulted in combat fatalities.

JFCOM Prototyping. A number of directorates at Joint Forces Command conduct prototyping to address joint capability gaps identified through analysis and experimentation. These prototypes can take the form of developmental operational concepts or limited materiel solutions. Though limited in scope, these prototypes can provide unique capabilities to joint operational commanders. A wide variety of JFCOM sources fund these efforts.

Joint Systems Integration Command (JSIC). The JSIC, a subordinate command stood up under USJFCOM in November 2001, rapidly integrates technology solutions, drives resolution of C2 interoperability problems, and provides unbiased evaluations of existing and emerging C2 capabilities to improve the joint warfighters' ability to plan and execute operations. FY 2006 interoperability demonstration projects include the Joint Systems Baseline Assessment 2006 (JSBA-06), Joint Battle Management Command and Control (JBMC2), Joint Test and Assessment (JT&A) for the Joint Close Air Support (JCAS), Joint Mission Thread (JMT), and the Deployable Joint Command and Control (DJC2) interoperability demonstration. FY 2006 warfighter utility assessments included blacklight, speech-to-speech technology, desktop reduction for DJC2, secure configuration tool suite, and the joint capabilities requirements tool. Prototype efforts focused on delivering the executive command and control capability. Systems were delivered to Combined Forces Command-Afghanistan; Multi-National Forces-Iraq; Multi-National Corps-Iraq; Commander, USEUCOM; and CJTF (Coalition Joint Task Force)-76.

Joint Warfighting Program (JWP). The JWP is designed to invigorate participation by the combatant commanders in joint experimentation, as directed in the transformation planning guidance. All elements of the JWP assist combatant commanders in specifying operational needs and developing solution alternatives for capability gaps. Projects are selected from nominations submitted by combatant commander staffs. DDR&E is the resource sponsor for JWP. JWP supports three activities:

- The **Joint Advanced Warfighting Program (JAWP)** captures lessons learned and assessments from joint contingency operations and formulates advanced joint concepts to be tested with joint experiments. JAWP is a catalyst for innovation and change supporting Defense transformation. JAWP staffing includes IDA analysts and USJFCOM military staff officers in the USJFCOM Joint Center for Operational Analysis (JCOA). The annual task list is reviewed and approved by a Board of Directors, chaired by USJFCOM and including Joint Staff J7, DDR&E, and OSD/Policy.
- The **Defense Adaptive Red Team (DART)** challenges conventional perspectives on Defense needs and solutions. Employing facilitated subject matter expert focus groups, expert investigations, and war gaming analysis, DART develops innovative and resilient concepts for conducting joint and coalition operations.
- **Technology Feeder Support (TFS)** subsidizes joint experimentation by major geographic and functional combatant commanders. In many cases, TFS is the main funding source for joint experimentation undertaken by combatant commander headquarters staffs. This activity permits development of complementing operational employment concepts and validates the usefulness of the demonstration capability. It also funds the incremental cost of including technology-based demonstrations in joint experiments.

Marine Corps Advanced Technology Demonstrations. The Marine Corps Advanced Technology Demonstrations program develops and demonstrates advanced technologies and system concepts in a quasi-operational environment in the less-than-lethal target effect. The program focuses on transition into the demonstration and validation phase, as well as prototypes that can be fielded to reduce risk in engineering and manufacturing development. Joint service efforts are in line with Science and Technology Project Reliance agreements and the Joint Chiefs of Staff Joint Warfare Capabilities. This program also funds the Combatants Warfighting Laboratory that provides conceptual operational assessment of emerging technologies. This program directly supports the Marine Corps' capability to promptly engage regional

forces in decisive combat on a global basis, as well as the capability to respond to all other contingencies and missions in the full spectrum of combat capabilities.

Office of Force Transformation (OFT). The OFT is the principal advisor to the Secretary of Defense on transformation within the DOD and is tasked to be the catalyst for transformation with the department. OFT applies limited RDT&E funding to achieve potentially high payoff transformational capabilities to satisfy deficiencies highlighted during the QDR, Transformation Planning Guidance, and various transformation appraisals. Examples of RDT&E efforts to date include work on a prototype full-spectrum effects platform for use in urban operations; a capability to re-direct laser energy at the tactical level for tactical applications/effects; performance trials of a high speed, composite watercraft with hydrodynamic lift; and creation of a concept development and experimentation program to promote joint war fighting capabilities.

Quick Reaction Special Projects (QRSP)—The QRSP supports three separate projects that provide rapid funding to expedite development and transition new technologies to the warfighter: the **Quick Reaction Fund** (QRF), the **Rapid Reaction Fund** (RRF), and the **Technology Transition Initiative** (TTI), a congressionally mandated project.

- The QRF provides the flexibility to respond to emergent warfighter needs in the execution years. With the rate of technology maturation, there is a need to take advantage of technology breakthrough in rapidly evolving disciplines. The QRF is managed by DDR&E, Plans and Programs. Each proposal is vetted through technology experts and the Joint Staff. Selected projects focus on new ideas or technology opportunities that can be completed within 6–12 months.
- The RRF provides financial resources for the CTTTF to accelerate development and fielding of transformational technologies. (See CTTTF description above).
- The TTI addresses the funding gaps that often exist between the time a technology is demonstrated and the time funding can

be programmed for procurement for use in an intended weapon or support system. The TTI Program was authorized by Section 242 of the fiscal year 2003 Defense Authorization Act. Its purpose is to facilitate the rapid transition of new technologies from the S&T base into acquisition programs. The statute requires DOD to establish a Technology Transition Manager reporting directly to USD (AT&L) and a Technology Transition Council (TTC) consisting of acquisition executives from each Military Department, members of the Joint Requirements Oversight Council, and the S&T executives from each Military Department and each Defense Agency. Since the start of the TTI Program in FY 2003, TTI has funded the new start activities of 32 transition projects. To date, eight of the projects have transitioned to service/agency programs of record or acquisition contracts. The MIOX Water Pen, Automated Change Detection, Titanium Nitrade Coating for H-46 Helicopter Compressor Blades, and the Semantic Web Network are being used by the warfighters 18–24 months earlier than would have been possible without TTI. Thirteen of the additional projects are in the process of being transitioned during FY 2006. Fourteen new projects were added in 2006.

Rapid Equipping Force (Army). The REF has a broad mission to rapidly increase mission capability while reducing risk to soldiers and others. The REF accomplishes this mission by (1) equipping operational commanders with off-the-shelf (government or commercial) solutions or near-term developmental items that can be researched, developed, and acquired quickly; (2) inserting future force technology solutions that engaged and deploying forces require by developing, testing, and evaluating key technologies and systems under operational conditions; and (3) assessing capabilities and advising Army stakeholders of findings that will enable U.S. forces to rapidly confront an adaptive enemy. The REF seeks to provide equipping solutions within 90 days and insertion solutions within 360 days. The REF organization takes its guidance from the Army G-3 and reports directly to the Vice Chief of Staff of the Army.

Rapid Technology Transition (Navy). The mission of the RTT program is to increase the rate that new, innovative, and potentially disruptive technologies are inserted into the Department of Navy

acquisition programs and the hands of the warfighter. A key aspect of the RTT program is its charter to transition technology from any source, including those not traditionally associated with defense technology. An effective and robust integration of commercial and military technologies can reduce costs and improve naval capabilities by keeping pace with the fast-moving changes in technologies and operational needs. The RTT program is structured to bring transition efforts to closure quickly, and to provide execution year funding for a rapid start, bridging the gap until the program of record can fund the completion of the technology insertion. The RTT program is designed to be pro-active in identifying opportunities and to work with resource sponsors, fleet and force users, and program managers in constructing viable technology transition efforts.

Warfighter Rapid Acquisition Program (Air Force). WRAP was created in August 2000 to speed proven innovations into official development programs in a fraction of the time that the PPBE process normally takes. WRAP cuts the timeline by offering RDT&E funds shortly after a candidate initiative requests WRAP funds that essentially fill the gap between innovation demonstration and POM funding. Beginning in fiscal year 2006, a single candidate may enter the process anytime, no longer waiting until September 1 as originally required. Further, the recommendation level has been delegated down from the Air Force Board to a council of HAF directorate chiefs, two/three-star military and civilian equivalents. The first initiative assessed (for $2.1 million) under the revised process took only nine calendar days from HAF receipt to a decision by the council.

Appendix F. Globalization

The Departments of Defense and State need to work together to successfully access the benefits of globalization, while at the same time contain its risks.

Recommendations from the report of the Defense Science Board Task Force on Globalization and Security (December 1999) address this balance.

1. Modernize career management practices in the Department of State, Office of Defense Trade Controls. Experienced personnel consistently choose other assignments for advancement.
2. Establish a single DOD authority for arms transfer decisions.
3. Liberalize International Traffic in Arms Regulations (ITAR) spare parts exemptions for NATO partners.
4. Modify ITAR implementation to facilitate cross-border collaborative relationships. Exploit existing alliance "bloc" approvals and foreign military sales exemptions (applies to recommendation #3 as well).
5. Improve flexibility of DOD international agreements. ITAR authority already exists to do this.
6. Establish uniform requirements for drafting agreements.
7. Make much greater use of industrial nondisclosure agreements to obtain certification of compliance for employees, partners, and other entities and individuals.
8. Define "inherently military" products for ITAR purposes; document non-inherently military products and parts.
9. Clarify, in positive terms, regulations regarding the scope and limitations of dual citizenship requirements for licensing.
10. Develop processes that permit expanded routine use of multiple destination licenses. Use licensing arrangements of a jointly-developed U.S. and South Korean jet trainer sales to two dozen buyers, as an example of success.

11. The Departments of Defense, State, and Commerce should establish a collaborative electronic licensing process and system.
12. Eliminate multiple licensing requirements. Move to one-stop licensing reviews for collaborative projects.
13. Reduce requirement for DOD review of technical data and hardware. DOD should document countries, end users, technical data, and hardware that no longer require review.
14. Expedite the exception to the National Disclosure Process. Over time it has doubled from an average of 135 days to an average of 210 days for difficult cases, while routine cases take no more than 30 days.
15. Increase emphasis in educating officials involved in arms transfer and international cooperative arms programs. The global arms and commercial worlds have changed dramatically and commercial capability has expanded to include a wider range of products and services.
16. Provide specific guidelines to U.S. defense industry concerning information necessary to be included in export license application.
17. Develop umbrella license structures for major foreign firms who are recipients of U.S. munitions list equipment or technology.
18. Reform the nontransfer and use certificate process through elimination of cases that are redundant or have already received waivers.
19. Examine and choose from options available from advanced technology to mitigate the consequences of unauthorized or inadvertent classified or export controlled disclosure.
20. Establish a consultative NATO process to address defense trade regulatory issues.
21. Provide clear ITAR definition of technical data.
22. Narrow focus of ITAR to reflect contemporary technology trends.
23. Provide resources for a modern export control system.

Appendix G. Glossary

ACAT	acquisition category
ACTD	Advanced Concept Technology Demonstration
ARDEC	Army Research, Development & Engineering Center
ASD	Assistant Secretary of Defense
ASD NII	Assistant Secretary of Defense for Networks and Information Integration
ASD SO/LIC	Assistant Secretary of Defense for Special Operations/Low Intensity Conflict
AWACS	Airborne Warning and Control System
C2	command & control
CbT RIF	Combating Terrorism Readiness Initiatives Fund
CJTF	Coalition Joint Task Force
CE	Concepts Experimentation
CENTCOM	Central Command
C3I	command, control, communication, and intelligence
CTTS	Combating Terrorism Technology Support
CTTTF	Combating Terrorism Technology Task Force
CW	Coalition Warfare
CWID	Coalition Warrior Interoperability Demonstration
CWP	Coalition Warfare Program
DAC	Defense Acquisition Challenge
DAE	Defense Acquisition Executive
DARPA	Defense Advanced Research Projects Agency
DART	Defense Adaptive Red Team
DDG	guided missile destroyer
DDR&E	Director, Defense Research and Engineering
DeVenCI	Defense Venture Catalyst Initiative
DISA	Defense Information Agency
DJC2	Deployable Joint Command & Control

DOD	Department of Defense
DOD CIO	Department of Defense Chief Information Officer
DODD	Department of Defense Directive
DOE	Department of Energy
DOTMLPF	doctrine, organizations, training, materiel, leader development, personnel, and facilities
DSB	Defense Science Board
DTRA	Defense Threat Reduction Agency
FCT	foreign comparative testing
FMTV	Family of Medium Tactical Vehicles
GAO	Government Accountability Office
GPS	Global Positioning System
HAF	Headquarters, Air Force
HMMVV	High Mobility Multipurpose Wheeled Vehicle
IDA	Institute for Defense Analyses
IED	improvised explosive devices
IOC	initial operational capability
IPA	Intergovernmental Personnel Act
IPT	integrated product teams
IR&D	independent research and development
IRL	integration readiness level
ITAR	International Traffic in Arms Regulations
IWN	immediate warfighter needs
JAWP	Joint Advanced Warfighting Program
JBMC2	Joint Battle Management Command & Control
JCAS	Joint Close Air Support
JCIDS	Joint Capabilities Integration and Development System
JCTD	Joint Capability Technology Demonstration
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JMT	Joint Mission Thread
JRAC	Joint Rapid Acquisition Cell

JROC	Joint Requirements Oversight Council
JSBA	Joint Systems Baseline Assessment
JSIC	Joint Systems International Command
JSTARS	Joint Surveillance and Target Attack Radar System
JT&A	Joint Test & Assessment
JTIDS	Joint Tactical Information Distribution System
JWP	Joint Warfighting Program
KPP	key performance parameter
LAA	limited acquisition authority
LANTIRN	Low Altitude Navigation and Targeting Infrared for Night
LHD	multipurpose amphibious assault ship
LRIP	low-rate initial production
MIDS	Multifunctional Information Distribution System
MRL	manufacturer's readiness level
MS A, MS B, MS C	Milestone A, Milestone B, and Milestone C
NATO	North Atlantic Treaty Organization
NDEP	National Defense Education Program
NESP	Navy EHF SATCO Program
NRT	Near-real time
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OFT	Office of Force Transformation
O&M	operations & maintenance
OSD	Office of Secretary of Defense
OUSD	Office of Under Secretary of Defense
OUSD (AT&L)	Office of Under Secretary of Defense for Acquisition, Technology, and Logistics
PGM	precision guided munitions
POM	program objective memorandum
PPBE	planning, programming, budgeting, and execution
QDR	Quadrennial Defense Review

QRF	Quick Reaction Fund
QRSP	Quick Reaction Special Project
RAA	rapid acquisition authority
RAA	rapid acquisition program
R&D	research and development
RDT&E	research, development, test, and evaluation
REF	Rapid Equipping Force
RFO	Rapid Fielding Organization
RIF	Readiness Incentives Plan
RIRS	Rapid Integration of Robotic System
RRF	Rapid Reaction Fund
RSIP	radar system improvement program
RTT	Rapid Technology Transition
SA	situational awareness
SAR	synthetic aperture radar
SBIR	Small Business Innovative Research
SDD	system design and demonstration
SEIT	system engineering integrating teams
SMART	Science, Math & Research for Transformation
SM-2	Standard Missile-2
SOCOM	Special Operations Command
S&T	science and technology
TFS	Technology Feeder Support
TRADOC	Training & Doctrine Command
TRANSCOM	Transportation Command
TRL	technology readiness level
TTC	Technology Transition Council
TTI	Technology Transition Initiative
TTPs	tactics, techniques, and procedures
UAV	Unmanned Aerial Vehicle
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics

USD (C)	Under Secretary of Defense Comptroller
USEUCOM	U.S. European Command
USJFCOM	U.S. Joint Forces Command
USSOCOM	U.S. Special Operations Command
VCJCS	Vice Chairman, Joint Chiefs of Staff
WRAP	Warfighter Rapid Acquisition Process