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December 2002

DEFENSE ACQUISITIONS

Factors Affecting Outcomes of Advanced Concept Technology Demonstrations

GAO-03-52

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GAO Highlights

Highlights of GAO-03-52, a report to the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

The Advanced Concept Technology Demonstration (ACTD) program was started by the Department of Defense (DOD) as a way to get new technologies that meet critical military needs into the hands of users faster and for less cost. GAO was asked to examine DOD's process for structuring and executing ACTDs.

What GAO Recommends

We are recommending that DOD strengthen its criteria for assessing the military utility of ACTD projects; consider ways to ensure funding is provided for acquisitions; and have the Secretary weigh in on decisions on whether to transition technologies that are tested under the program.

DOD generally concurred with the recommendations on improving military utility assessments and ensuring timely funding for the transition of successful ACTD projects. DOD partially concurred with our recommendation on obtaining high-level concurrence on any decision not to transition ACTD projects addressing joint requirements.

www.gao.gov/cgi-bin/getrpt?GAO-03-52.

To view the full report, including the scope and methodology, click on the link above. For more information, contact Katherine Schinasi at (202) 512-4841 or schinasik@gao.gov.

What GAO Found

Since the ACTD program was started in 1994, a wide range of products have been tested by technology experts and military operators in realistic settings—from unmanned aerial vehicles, to friend-or-foe detection systems, to biological agent detection systems, to advanced simulation technology designed to enhance joint training. Many of these have successfully delivered new technologies to users. In fact, 21 of 24 projects we examined that were found to have military utility delivered at least some technologies to users that meet military needs.

Though the majority of the projects we examined transitioned technologies to users, there are factors that hamper the ACTD process. For example:

- Technology has been too immature to be tested in a realistic setting, leading to cancellation of the demonstration.
- Military services and defense agencies have been reluctant to fund acquisition of ACTD-proven technologies, especially those focusing on joint requirements, because of competing priorities.
- ACTDs' military utility may not have been assessed consistently.

Some of the barriers we identified can be addressed through efforts DOD now has underway, including an evaluation of how the ACTD process can be improved; adoption of criteria to be used to ensure technology is sufficiently mature; and placing of more attention on the end phase of the ACTD process. Other barriers, however, will be much more difficult to address in view of cultural resistance to joint initiatives and the requirements of DOD's planning and funding process.

Advanced Concept Technology Demonstrations Projects

Counterproliferation I

Miniature air-launched decoy

Military operations in urban terrain

Predator

Source:DOD

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Abbreviations

ACTD Advanced Concept Technology Demonstration
DOD Department of Defense
GCCS Global Command and Control System
OSD Office of the Secretary of Defense
TRL Technology Readiness Level

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

December 2, 2002

The Honorable Daniel Akaka
Chairman
The Honorable James Inhofe
Ranking Minority Member
Subcommittee on Readiness and Management Support
Committee on Armed Services
United States Senate

The Advanced Concept Technology Demonstration (ACTD) program was initiated by the Department of Defense (DOD) in 1994 as a way to get new technologies that meet critical military needs into the hands of users faster and at less cost than the traditional acquisition process. Under its traditional process, which takes an average of 10 to 15 years to develop a product, DOD explores various weapon concepts, defines what the specific weapon system will look like, refines plans through systems development and demonstration, and then produces the equipment in larger-scale quantities. By contrast, under the ACTD process, which takes an average of 2 to 6 years, military operators and developers test prototypes, which have already been developed and matured, in realistic settings. If they find these items to have military utility, DOD may choose to buy additional quantities or just use items remaining after the demonstration. If users find these items do not have utility, DOD may reject them altogether—an outcome that enables DOD to save time and money.

A key distinction between the traditional acquisition process and the ACTD process is that the ACTD process is intentionally set up to be much more flexible and streamlined. Decisions to move from stage-to-stage are less formal and the process itself is managed by a set of guidelines, which contain advice and suggestions, as opposed to formal directives and regulations. This was done to encourage innovation and creativity as well as participation from the services and the defense agencies on projects that have joint applications.

You requested that we examine DOD's process for structuring and executing ACTDs, particularly with respect to DOD's ability to transition promising technologies to military users. In doing so, we reviewed 24 of the 99 projects that have been undertaken so far. Of the 24 projects reviewed, 21 had transitioned at least some technologies found to have military utility to users as acquisition programs, residual items, or both.

Among these were the Predator and Global Hawk unmanned aerial vehicles, devices to combat weapons of mass destruction, weapons and equipment for use in urban combat, and various information systems tools and decision aides.

Results in Brief

Though the majority of the projects we examined had transitioned technologies to users, we found that there are opportunities for DOD to improve the ACTD process. These include (1) ensuring candidate technologies are mature enough to be tested in a realistic setting, military services and defense agencies sustain their commitment to projects, especially those focusing on joint requirements, and appropriate expertise is employed for carrying out demonstrations and transitions; and (2) developing specific criteria to evaluate demonstration results. Such actions would enable the ACTD process to produce better candidates and help DOD to prevent delays and funding gaps.

DOD recognizes that the ACTD process could be improved. In response, it has adopted criteria that should help ensure technologies are sufficiently mature for the demonstrations. It is strengthening guidance so that projects can be planned and managed better. To maximize outcomes, DOD still needs to strengthen assessments of military utility and ensure that projects are adequately funded through the transition. We are making recommendations to DOD to address both issues.

In commenting on a draft of this report, DOD generally concurred with our recommendations on improving military utility assessments and on ensuring timely funding for the transition of successful ACTD projects. DOD partially concurred with our recommendation on obtaining high-level concurrence on any decision not to transition ACTD projects addressing joint requirements.

Background

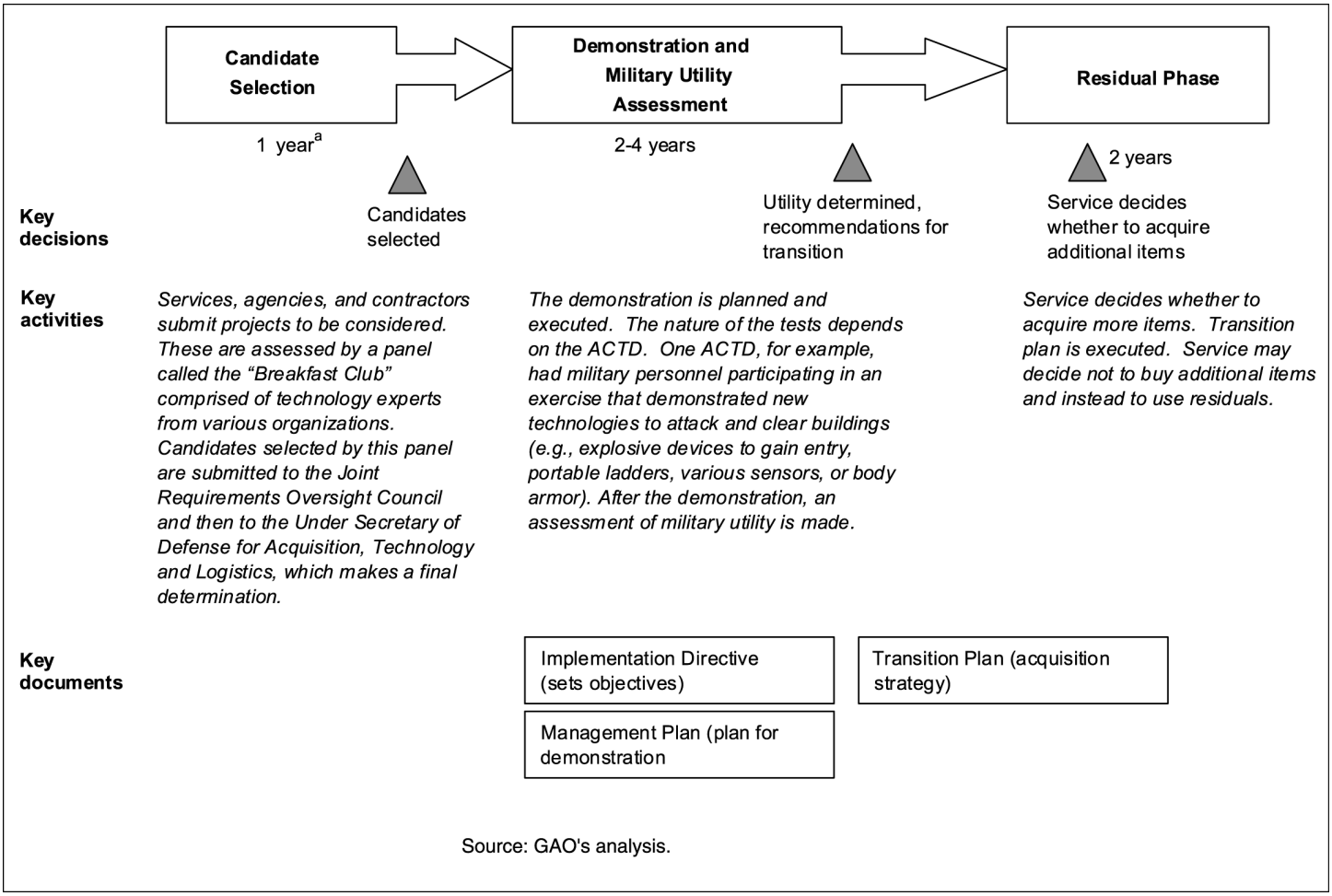
The ACTD process is intended to be much more flexible and streamlined than DOD's formal acquisition process and in turn to save time and money. Under the ACTD program, prototypes are developed and provide users with the opportunity to demonstrate and assess the prototypes' capabilities in realistic operational scenarios. From these demonstrations, users can refine operational requirements, develop an initial concept of operations, and determine the military utility of the technology before deciding whether additional units should be purchased. Not all projects are selected for transition into the normal acquisition process. Specifically, potential users can conclude that the technology (1) does not have

sufficient military utility and that acquisition is not warranted or (2) has sufficient utility but that only the residual assets of the demonstration are needed and no additional procurement is necessary. Separate technologies within one project may even have varied outcomes.

DOD's traditional approach to developing and buying weapons—which takes an average of 10 to 15 years—is marked by four phases: exploring various weapon concepts, defining what the specific weapon system will look like, refining plans through systems development and demonstration, and producing the equipment in larger-scale quantities and operating and supporting it in the field. Before a program can proceed to each phase, defense officials review its progress to evaluate the ability to meet performance goals and whether risk is under control.

The ACTD process is marked by three phases: selection of the projects, demonstration of the technologies, and residual use of prototypes and/or the transition of them to acquisition programs if the services or defense agencies decide to acquire more. The selection process begins via a data call to both the research and development and warfighting communities. The "Breakfast Club," a panel of technology experts from various organizations, reviews the potential candidates. Candidates selected by this panel are submitted to the Joint Requirements Oversight Council for prioritization and then to the Under Secretary of Defense for Acquisition, Technology and Logistics for a final selection. Decisions to move from stage-to-stage, are less formal than the formal acquisition process, and the process is managed by a set of Office of the Secretary of Defense (OSD) guidelines, which contain advice and suggestions, as opposed to formal directives and regulations. While ACTD teams are to prepare management plans for the projects that spell out roles and responsibilities, objectives, and approaches, these plans are supposed to be flexible, short (less than 25 pages), and high level. Figure 1 illustrates the major phases of the ACTD process.

Figure 1: ACTD Process



Source: GAO's analysis.

[a] This phase had been shortened for fiscal year 2003 and 2004 candidates.

The ACTD demonstration phase typically lasts an average of 2 to 4 years, with an added 2-year residual phase. According to OSD, this provides ample time to develop fieldable prototypes and to allow users to evaluate them. For less complex systems or systems that are available quickly (e.g., commercial-off-the-shelf systems), the time line may be significantly shorter. Similarly, for very complex systems that require extensive integration and developmental testing, more time may be required. A key to keeping the time frame short, according to DOD, is beginning the demonstration with mature technology. This prevents delays associated with additional development and rework.

The ACTD process places the highest priority on addressing joint military needs, although some ACTDs focus on service specific capabilities. For example, DOD has found that combat identification systems across the services needed to be enhanced to reduce fratricide so that systems belonging to individual services and components, and even allies, could work together more effectively. As a result, it undertook an ACTD project that tested new technology designed to improve the capability of combat forces to positively identify hostile, friendly, and neutral platforms during air-to-surface and surface-to-surface operations. Another ACTD project was designed to demonstrate the capability to conduct joint amphibious mine countermeasure operations. Recently, some ACTD programs have focused on enhancing homeland security with domestic agencies. For example, DOD is now testing a command and control system that will allow emergency personnel first responding to the scene of an attack to talk to each other and have a better situational awareness.

ACTDs are funded by a variety of sources, including the office within OSD with the oversight responsibility for the ACTD program and the military services or defense agencies responsible for conducting the demonstrations and/or the transitions. In fiscal year 2001, a total of $546 million was budgeted for ACTDs—$120 million from OSD and $426 million from the services and agency partners. Participating combatant commands provide additional resources through their support of training, military exercises, and other resources. Funding to acquire and maintain additional units comes from service and agency budgets.

Twenty-one of 24 Projects Transitioned at Least Some Technologies to Users

Of the 24 projects we reviewed, 21 transitioned at least some technologies to users, meaning that users found that these had some level of military utility and that a military service or a defense agency chose to accept and fund their transition in the form of residual assets or as an acquisition.

- For 13 of these projects, the services or agencies decided to acquire more of the items tested, and as a result, transitioned the items into formal acquisition programs. Two of the 13 had no residual assets in use.
- For 8 projects, the services/agencies decided not to acquire additional items, but to continue using the residual assets.
- Three projects had no residual assets and no acquisition planned.

However, some of these projects experienced mixed outcomes—e.g., some technologies may have ended up in residual use while others were acquired or rejected altogether or the lead military service may have

rejected the technology while other components decided to acquire it. For example:

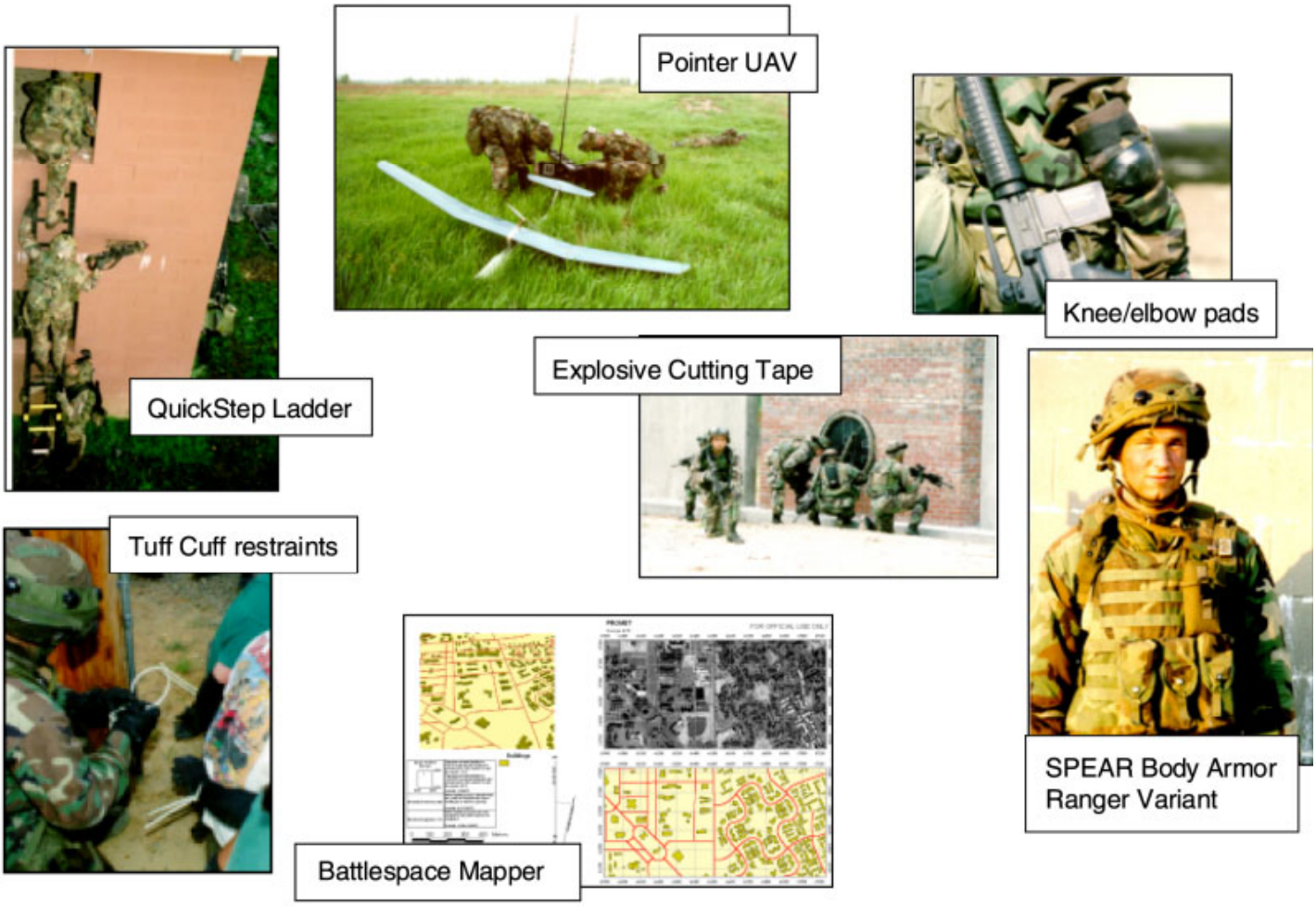
- The Counterproliferation I project consisted of a variety of technologies, including sensors, targeting systems, and advanced weapons, designed to find and destroy nuclear, biological, and chemical facilities. The technologies were used in military operations in Kosovo. For example, an improved infrared sensor that can assess bomb damage to facilities was accepted by the Air Force as an upgrade to its standard targeting pod. Two other technologies—a hard target-penetrating bomb and a fuzing[1] system—have transitioned to production and are expected to achieve initial operational capability in fiscal year 2003. However, the project's weapon borne sensor technology did not prove to be mature enough and was dropped from the ACTD prior to any demonstrations.

- The Link-16 project demonstrated an interoperability between the Link-16 communications link and other variable message format systems to improve situational awareness, interdiction, surveillance, and close air support. No service has adopted it for formal acquisition, but some regional combatant commanders and lower-level commands have purchased additional systems. Since the system was not adopted across DOD, its utility could not be optimized.

- The Military Operations in Urban Terrain project field-tested 128 items designed to enhance operations in urban environments—such as attacking and clearing buildings of enemy troops. Of these, 32 technologies were determined to have merit and were kept as residual items to be further evaluated. Some of these have already transitioned or are planned for transition to acquisition programs, including a door-breaching round, a man-portable unmanned aerial vehicle, elbow and kneepads, explosive cutting tape, ladders, body armor, and flexible restraining devices.

[1] These systems typically recognize or detect targets, initiate detonation, and determine the direction of detonation.

Figure 2: Technologies Tested in Military Operations in Urban Terrain ACTD



Source: DOD.

Notes: SOF Personal Equipment Advanced Requirements (SPEAR), Unmanned Aerial Vehicle (UAV).

Table 1: Summary of Outcomes

Moved into acquisition (in whole or in part)	Used residuals	No residual or acquisition
Battlefield Awareness and Data Dissemination Technologies to enhance sharing of intelligence and other data	**Adaptive Course of Action** Technologies to facilitate crisis planning (e.g., enabling simultaneous viewing of battle plans as they develop)	**Consequence Management** Technologies to detect and model biological warfare agents.
Unattended Ground Sensors Sensors to enhance capabilities to detect, locate, identify, and report time-critical targets	**Common Spectral Measurement and Signature Exploitation** Technologies to show tactical utility of measurement and signature intelligence	**Joint Modular Lighter** Modular causeway system
Counterproliferation I Technologies to help detect and respond to nuclear, biological, and chemical threats	**Information Assurance: Automated Intrusion Detection Environment** Technologies to assess attacks on computer networks	**Miniature Air Launched Decoy** Small air-launched decoy system to suppress enemy air defense systems
Small Unit Logistics Software for logistics mission planning	**Joint Logistics** Software to support logistics planning	
Human Intelligence and Counterintelligence Support Tools Off-the-shelf technology to support intelligence operations	**Precision/Rapid Counter Multiple Rocket Launcher** Technologies designed to facilitate strikes against North Korean long-range artillery	
Joint Countermine[a] Technologies to facilitate amphibious mine countermeasure operations	**Navigation Warfare** Jamming , antijamming, and other electronic technologies	
Military Operations in Urban Terrain Technologies to assist operations in urban environments	**Personnel Recovery Mission Software** Software to facilitate personnel recovery operations	
Predator Medium altitude endurance unmanned aerial vehicle	**Link 16** Software to facilitate sharing of tactical information across military services	
Portal Shield Technologies to detect and identify biological attacks on air bases or ports		
Rapid Force Projection Initiative[a] Long-range precision sensors, weapon systems, munitions, and digital communications systems designed to defeat an enemy armored force		
Global Hawk High-altitude, long endurance unmanned aerial vehicle		
Synthetic Theater of War Simulation technologies to support joint training and mission rehearsals		
Combat Identification[a] Technologies to identify friendly and hostile forces		

[a]One of three projects that did not also have residual assets in use.

Source: GAO's analysis.

Some Factors Can Hamper the ACTD Process

Though the majority of the projects we examined transitioned technologies to users, we identified a range of factors that hampered this process. Specifically:

- The technology has been too immature to be tested in a realistic setting, leading to possible cancellation of the demonstration.
- The military services and defense agencies have been reluctant to fund acquisition of ACTD-proven technologies, especially those focusing on joint requirements, because of competing priorities.
- Appropriate expertise has not been employed for demonstrations and transitions.
- Transition for software projects has not been adequately planned.
- DOD lacks specific criteria to evaluate demonstration results, which may cause acquisition decisions to be based on too little knowledge.

At times, top-level support can overcome these barriers. But more systemic improvements focused on transition planning and funding commitment could reduce the need for high-level intervention. Figure 3 highlights the specific factors we identified.

Figure 3: Illustration of Factors Influencing Outcomes

	Selection	Demonstration	Transition	Potential result
Technology Immaturity	No structured knowledge based method for testing technology maturity →	Technology does not work as intended →	Additional development needed →	ACTD is canceled of process is slowed, or technology is found to lack military utility.
Sustained commitment	Lack of service/component buy-in, particularly for joint requirements due to competing priorities of for other reasons →		Service/component reluctant to fund acquisition →	ACTD assessed as having utility assessed as having utility but no additional items are procured or process is slowed.
Management	Poor planning for ACTD demonstrations and transitions →	Appropriate expertise may not be employed →	Issues relating to contracting, funding, interoperability, etc. were not well anticipated →	ACTD demonstration and/or transition process may be slowed.
Software planning and management	Transition for software projects not adequately planned →		Larger platform may not be able to accommodate software module →	Transition may be slowed.
Military utility assessments	Lack of specific criteria to evaluate demonstration results →		Assessments of demonstration results vary widely in scope and content →	Acquisition decisions may not be based on sound data.

Source: GAO's analysis.

Technology Maturity

Because ACTDs are often conducted during large-scale, force-on-force military exercises, any new systems being tested must be dependable, able to perform as intended, and available on schedule in order not to negatively affect the exercises. As such, DOD has stressed that new technologies proposed for ACTDs should be "mature," that is, they should have already been demonstrated to perform successfully at the subsystem or component level.

The technology of the ACTDs in our sample was not always mature. In some cases, problems were fairly basic, such as a technology having inadequate power supply or being too heavy and bulky to carry out its intended operation. In other cases, technologies had not reached a point where they could be tested in a realistic setting, forcing users to forego certain parts of a test. For example:

- The Joint Countermine project tested 15 technologies, including detection systems and clearance/breaching systems. During demonstration, users found that detection technologies had unacceptably high false alarm rates and a mine and heavy obstacle clearing device was simply too heavy, bulky, slow and difficult to

operate remotely. Moreover, several systems could not be demonstrated on their intended platforms, or even associated with a suitable substitute platform. Further, a number of critical operational sequences, such as launch/recovery, ordnance handling, and system reconfiguration, had not been demonstrated. As a result, only some technologies in this project have transitioned.

- The Consequence Management project examined 15 technologies designed to identify and respond to a biological warfare threat. During demonstration, users found that some of the items used to collect samples failed to operate and did not have sufficient battery capability and that switches broke. None of the other technologies performed flawlessly, and limitations such as size and weight made it apparent that they were not field ready. None of the technologies from this project entered into the acquisition process, nor did DOD continue to use any of the residual assets.[2]

- Technologies supporting the Joint Modular Lighter System, a project testing a modular causeway system, failed during the demonstration because they had not been properly designed to withstand real world sea conditions. Consequently, the ACTD was concluded without a demonstration.

- The Navigation Warfare project, which focused on validating technologies for electronic warfare countermeasures, was terminated after DOD found that some of the technologies for the project could not be demonstrated. Some of the jamming technologies associated with this project are still being evaluated.

The technical maturity of software is also vital to successful demonstrations. If software is not able to work as intended, a project's demonstration may be limited as a consequence. For this reason, one ACTD operations manager stressed that software technologies should be as mature as possible at the start of the ACTD. One ACTD included in our review experienced problems with software immaturity going into demonstration. Because software technologies in the Battlefield

[2] However, this ACTD did produce a published concept of operations for both units involved in the demonstrations, the Technical Escort Unit and the Chemical-Biological Incident Response Force. In addition, this ACTD provided the first opportunity for these units to work together and demonstrated the ability of DOD units to integrate with other federal, state, and local agencies.

Awareness and Data Dissemination ACTD were not mature, certain planned exercises could not be concluded.

Before fiscal year 2002, OSD's guidance only generally described the expectations for technology maturity and OSD did not use a consistent, knowledge-based method for measuring technology maturity of either hardware or software technologies. Specifically, OSD officials selecting the ACTDs used simple ranking schemes to capture the degree of technical risk after consulting with subject area experts. The results of these efforts were not usually documented. Studies conducted by the Congressional Budget Office in 1998 and DOD's Inspector General in 1997 also found that without guidelines on how to assess maturity, DOD officials defined mature technology in widely contrasting ways.

In the last year, OSD has changed its guidance to address this problem. Specifically, it now requires technology maturity to be assessed using the same criteria—technology readiness levels (TRLs)—that DOD uses to assess technical risk in its formal acquisition programs.[3] This change is discussed in more detail later in this report.

Sustaining Commitment

Although OSD provides start-up funding for ACTDs, the military services and defense agencies are ultimately responsible for financing the acquisition and support of equipment or other items that may result from an ACTD. At times, however, the military services did not want to fund the transition process. This action either slowed down the acquisition process or resulted in no additional procurements. Projects that were particularly affected by this reluctance included those that tested unmanned aerial vehicles and software applications for enhancing the performance of a system to defeat enemy artillery. In other cases, DOD leaders stepped in to support the projects since there was a strong need for the technology and/or an extremely successful demonstration.

For example:

- The Predator is a medium-altitude unmanned aerial vehicle used for reconnaissance that progressed from a concept to a three-system

[3] See U.S. General Accounting Office, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999).

operational capability in less than 30 months. The Predator ACTD was initiated in 1995. Since then, the Predator has been deployed in a range of military operations, most recently in the war in Afghanistan. Twelve systems, each containing four air vehicles, are being procured. The Air Force was designated as the lead service for the ACTD, even though it had shown no interest in this or other unmanned aerial vehicle programs. A transition manager was never assigned to this project. The Defense Airborne Reconnaissance Office was also reluctant to field and support the system beyond the test-bed phase. Further, at one point, the project almost ran out of funds before its end. Nevertheless, the Joint Staff directed the Air Force to accept the system from the Army and the Navy, which had acted as co-lead services throughout the demonstration phase.

- The Global Hawk is a high-altitude unmanned aerial vehicle designed for broad-area and long-endurance reconnaissance and intelligence missions. It has also been successfully used in recent military missions. The Air Force was also reluctant to fund this program. Nevertheless, eventually the Air Force had to accept the system since the system answered a critical need identified during the Gulf War, was considered to be a success in demonstration, and received support from the President, the Secretary of Defense, and the Congress.

In at least one case, the Precision/Rapid Counter Multiple Rocket Launcher ACTD, DOD did not overcome reluctance and, in turn, missed out on an opportunity to acquire important warfighting capabilities with joint applications. This project successfully demonstrated improved capability in rocket launch detection, command and control, and counterfire necessary for countering the threat from North Korean multiple rocket artillery with a system called the Automated Deep Operations Coordination System (ADOCS). Following the demonstration, the Army—the lead service for the project—decided not to formally acquire technologies since it was pursuing a similar development program. Moreover, the Navy, the Air Force, and the United States Forces, Korea, have acquired and deployed their own unique versions of the software.

The military services may not want to fund technologies focusing on meeting joint requirements either because they do not directly affect their individual missions and/or because there are other service-specific projects that the services would prefer to fund. At the same time, OSD officials told us that they lack a mechanism for ensuring that decisions on whether to acquire items with proven military utility are made at the joint level, and not merely by the gaining organizations, and that these

acquisitions receive the proper priority. DOD's Joint Requirements Oversight Council, which is responsible for validating and prioritizing joint requirements, plays a role in deciding which ACTD nominees are selected for demonstration, but it does not have a role in the transition decision process, and is not currently concerned with transition outcomes. Moreover, no other DOD organization appears to have been given authority and responsibility for decisions regarding joint acquisition, integration, and support issues.

Another factor hindering transition funding has been the lack of alignment of the ACTD transition process with the DOD planning process. The planning process requires the services/agencies to program funds for technology transition long before the services/agencies assuming transition responsibilities know whether a candidate technology is useful to them. Consequently, at times, the services/agencies had to find funds within their own budgets to fund the transition.

ACTD Management

The problem of not involving the staff with the appropriate expertise to carry out demonstrations and transition planning —in all phases of the ACTD process—may also affect ACTD outcomes. OSD's guidance recommends that ACTDs use Integrated Product Teams to organize and conduct ACTDs. Integrated Product Teams bring together different skill areas (such as engineering, purchasing, and finance). By combining these areas of expertise into one team, there is no need to have separate groups of experts work on a product sequentially. We have reported in the past that this practice improved both the speed and quality of the decision-making process in developing weapon systems. [4] Conversely, not involving the acquisition, test, and sustainment communities precludes the opportunity for OSD to understand during the demonstrations the significant issues that will arise after transition. In some cases, ACTD projects did not employ a "transition manager" as called for by OSD's guidance. This manager, working for the service or the agency leading the demonstration, is to prepare the transition plan and coordinate its execution. When a manager was not designated, these duties often fell to a technical manager, who was primarily responsible for planning, coordinating, and directing all development activities through the demonstration. One ACTD—the Human Intelligence and

[4] See U.S. General Accounting Office, *Best Practices: DOD Teaming Practices Not Achieving Potential Results*, GAO-01-510 (Washington, D.C.: Apr. 10, 2001).

Counterintelligence Support Tools—experienced high turnover in the "operational manager" position. Specifically, it had five different operational managers over its life. The operational manager, who represents the ACTD sponsoring command, is responsible for planning and organizing demonstration scenarios and exercises, defining a concept of operations for the ACTD, assessing whether the project has military utility, and making recommendations based on that assessment.

In addition to not involving the right people, at times ACTDs simply did not anticipate issues important to a successful transition early in the process. OSD's guidance calls on teams to prepare a transition strategy that includes a contracting strategy and addresses issues such as interoperability, supportability, test and evaluation, affordability, funding, requirements, and acquisition program documentation. The guidance also suggests that the transition strategy anticipate where in the formal acquisition process the item would enter (e.g., low rate initial production or system development and demonstration) or even whether the item could be acquired informally, for example, through small purchases of commercially available products. Specifically, the lead service has the responsibility to determine the transition timing, nature, and funding methodology. In two ACTDs, a transition strategy was never developed. Both of these projects ended up transitioning only as residual assets.

The 1998 Congressional Budget Office study identified similar problems with transition planning. The study specifically noted that while DOD calls for each management plan to include some discussion of possible acquisition costs, few plans did so. The Congressional Budget Office asserted that this was probably because so little was known about a project's future at its start. Even when more was known later in the demonstration, however, plans remained sketchy.

Software Challenges

Software technologies present special planning challenges for transition. Because of the fast-paced nature of advanced technology, it is critical to move software ACTD projects through the demonstration and transition phases quickly so that they are not outdated by the time they are acquired or integrated into existing software programs and databases. At the same time, transition might be slowed by incompatibilities between the operating systems and/or language of the technologies of the ACTD candidate(s) and those of the intended host. This can be difficult since newer applications, particularly commercial-off-the-shelf systems, may be built to different technical standards or use different languages or supporting programs.

It was apparent in several ACTDs that there were technical difficulties in integrating the new technologies into their intended platforms. For example, the Adaptive Course of Action project tested software tools intended to enhance DOD's Global Command and Control System (GCCS) specifically by facilitating near real-time collaborative joint planning by multiple participants during crisis action planning. In this case, transition has been slowed and may possibly not occur because the software module cannot be easily integrated into GCCS (partially due to its use of a different database program) and DOD has not analyzed other functionality and security issues associated with adding the new module. In another project, Battlefield Awareness and Data Dissemination, which focused on providing a synchronized, consistent battlespace description to warfighters, the transition had a mixed outcome. One collection of software applications was successfully transitioned to GCCS, but the transition of others was not as successful. The software application that was successfully integrated was an update of existing GCCS applications and the developers of the software had good working relationships with GCCS managers. The software that experienced problems was not as compatible.

Military Utility Assessments

Another factor potentially affecting the outcomes of ACTDs is the lack of specific criteria for making assessments of military utility. These assessments evaluate the technologies of ACTD projects after the demonstrations. It is important that OSD have some assurance that the assessments are fact-based, thorough, and consistent, because they provide the basis upon which the military users can base their transition recommendations. OSD's guidance calls for measures of effectiveness and performance to help gauge whether an item has military utility. It defines measures of effectiveness as high-level indicators of operational effectiveness or suitability and measures of performance as technical characteristics that determine a particular aspect of effectiveness or suitability. But the guidance does not suggest how detailed the measures should be, what their scope should be, or what format they should take. Consequently, we found that the scope, content, and quality of military utility assessments varied widely. For some of the ACTDs we reviewed, no documentation on military utility could be found. Without more specific criteria, customized for each ACTD, there is a risk that decisions on whether to acquire an item will be based on unsound data.

Initiatives Are Underway to Improve ACTD Outcomes

DOD has undertaken several initiatives to improve the ACTD process, including adopting criteria to ensure technology is sufficiently mature; evaluating how the ACTD process can be improved; and placing more attention on transition planning and management (rather than on simply the selection and demonstration phases) through additional guidance, training, and staffing. These initiatives target many of the problems that can hinder success; however, DOD has not addressed the need to establish specific criteria for assessing the military utility of each of the candidate technologies and to establish a mechanism to ensure funding is made available for the transition.

Specifically, DOD headquarters, commands, military services, and a defense agency have undertaken the following efforts.

- OSD has adopted the same TRL criteria for fiscal year 2003 ACTD projects that DOD uses for assessing technical risks in its formal acquisition programs. These criteria apply to hardware as well as software. Adhering to this standard should help DOD to determine whether a gap exists between a technology's maturity and the maturity demanded for the ACTD. TRLs measure readiness on a scale of one to nine, starting with paper studies of the basic concept, proceeding with laboratory demonstrations, and ending with a technology that has proven itself on the intended item. According to a senior OSD official, projects must be rated at least at TRL 5 when they enter the demonstration phase. This means that the basic technological components of the item being demonstrated have been integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. An example would be when initial hand-built versions of a new radio's basic elements are connected and tested together. We reviewed submissions for the final 16 fiscal year 2003 ACTD candidates and found that actual and projected TRLs of each technology ranged from 4 to 9.[5] According to a senior OSD official, during the review of fiscal year 2003 candidates, there were some technologies with a TRL rating of 4 were accepted for demonstration because the need for them was compelling.

[5] See appendix I for a description of TRLs. A single ACTD candidate could be comprised of multiple technologies assessed at different readiness levels. We have found that a TRL of 7 at the state of product development indicates a low risk for cost and schedule increases.

- In early 2002, OSD reviewed the ACTD process to examine current ACTDs for relevancy in a changing military environment and identify ways to make sure projects are value-added as well as to enhance transition. The results of this review included recommendations for additional discipline and informational requirements in the ACTD candidate selection phase, increased program management focus on the execution phase, and more emphasis on management oversight.

- OSD has also designated a staff member to manage transition issues and initiated a training program for future ACTD managers. This training will emphasize technology transition planning and execution.

- To enhance future technology transitions, OSD has taken action to better align the ACTD selection and the DOD planning and programming process. Moreover, OSD has issued new guidance for the fiscal year 2004 ACTD candidates that calls on the gaining military or defense agencies to identify funds specifically for the demonstration and the transition, appoint a dedicated transition manager, and develop a transition plan before it will approve future ACTD candidates.

- The combatant commanders, military services, and a defense agency are also strengthening their guidance for conducting ACTDs. For example, the U.S. European Command has updated its guidance and the U.S. Joint Forces Command has developed detailed guidance for selecting and managing ACTDs. Additionally, the U.S. Pacific Command has developed definitive policies, procedures, and responsibilities for sponsoring and co-sponsoring ACTD programs. The U.S. Special Operations Command issued a policy memorandum for ACTD participation. The Army has begun development of an ACTD tracking system. It is also requiring ACTD candidate submissions to include TRL and other quantitative information. The Air Force has drafted both a policy directive and an instruction regarding ACTDs. The four services have begun meetings amongst themselves to discuss and review their future ACTD candidates. The Defense Information Systems Agency is also engaged in an effort to improve the transition of software technologies to users of systems such as GCCS.

Collectively, these efforts target many of the factors that can impede the ACTD process. However, OSD has not yet taken steps to develop specific criteria for assessing whether each of the ACTD candidates meet military needs. More guidance in this regard, particularly with respect to the scope and depth of these assessments and the need to document their results, can help to make sure (1) decisions are based on sound information and

(2) items that could substantially enhance military operations are acquired. Moreover, while OSD is requiring services and agencies to identify funds for demonstration and acquisition early in the process, it does not have a mechanism for ensuring that this funding will be provided. As a result, it may continue to experience difficulty in getting the services to fund projects that meet joint needs but do not necessarily fit in with their own unique plans.

Conclusions

The ACTD process has achieved some important, positive results in terms of developing and fielding new technologies to meet critical military needs quickly and more cost-effectively. DOD recognizes that further improvements are needed to increase opportunities for success. Its efforts to strengthen assessments of technology readiness and management controls—combined with more consistent, fact-based assessments of military utility—should help ensure that the ACTD program will produce better candidates. However, DOD's initiatives will be challenging to implement since they require decision makers to balance the need to preserve creativity and flexibility within the ACTD process against the need for structure and management control. Moreover, to fully capitalize on the improvements being made, DOD needs to ensure that the services sustain their commitment to projects, especially those shown to meet critical joint military needs. This will also be a challenge because it will require DOD to overcome the services and agencies' cultural resistance to joint initiatives and its lack of a programming and funding process for joint acquisitions. A place to make a good start in this regard may be to require the services and agencies to designate funding for ACTD transition activities and to have the Secretary of Defense weigh in on decisions on whether to continue to acquire technologies that are tested and proven under the ACTD program.

Recommendations for Executive Action

To ensure that transition decisions are based on sufficient knowledge, we recommend that the Secretary of Defense develop and require the use of specific criteria for assessing the military utility of each of the technologies and concepts that are to be demonstrated within each ACTD. The criteria should at a minimum identify measurement standards for performance effectiveness and address how results should be reported in terms of scope, format, and desired level of detail.

To ensure funding of the transition and its aftermath, we recommend that the Secretary of Defense explore the option of requiring the services or defense agencies to develop a category within their budgets specifically

for ACTD transition activities, including procurement and follow-on support.

To ensure that transition decisions reflect DOD's priorities, we recommend that the Secretary of Defense require that the lead service or defense agency obtain the concurrence of the Secretary's designated representative on any decision not to transition an ACTD that is based on joint requirements and determined to be militarily useful.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD generally concurred with the first two recommendations and outlined the actions to be taken to (1) define ACTD measurement standards and reporting formats for military utility assessments, and (2) work with the services to enhance their ability to enable follow-on transition and support of ACTD products. DOD partially concurred with our recommendation on the transition of militarily useful technology intended to address joint requirements. DOD stated that it would work to provide more information to the Joint Staff on specific ACTD results and evaluate quarterly meetings between the service acquisition executives and the Under Secretary of Defense for Acquisition, Technology and Logistics as a possible forum to raise issues on specific ACTDs. These actions may not address the intent of the recommendation, which is to provide the joint warfighter the opportunity to influence the DOD's investment decisions. The ACTD program offers a good opportunity in the DOD acquisition system to evaluate equipment and concepts in the joint warfighting environment. However, while ACTDs often start based on a joint requirement, that perspective and priority may change when it comes to transition issues. For the DOD actions to effectively address this condition, the joint perspective should be more effectively represented in ACTD transition issues. DOD's comments are reprinted in appendix II.

Scope and Methodology

Between fiscal year 1995 and 2002, DOD initiated 99 ACTDs. As we began our review, 46 of these had completed their demonstration phase or had been canceled. We reviewed 24 of these in detail. We could not review the remainder to the same level of detail because their military utility assessments were incomplete or not available and because we did not choose to present information on those projects that were highly classified. To assess the results of the completed ACTDs, we examined each project's military utility assessment documents, final program reports, lessons learned reports, and other pertinent ACTD documents, such as the program acquisition strategies. We interviewed operational

and technical managers and other knowledgeable program officials at the unified combatant commanders, defense agencies, and the services to discuss the phases of each ACTD project and its transition status.

Specifically, we interviewed officials at the Science and Technology Office of the United States Pacific Command, Camp Smith, Hawaii; the European Command, Stuttgart, Germany; the Central Command, Tampa, Florida; the Special Operations Command, Tampa, Florida; the Joint Forces Command, Norfolk, Virginia; the Air Combat Command, Hampton, Virginia; the Army Training and Doctrine Command, Hampton, Virginia; and the Marine Corps Warfighting Lab, Quantico, Virginia. We also contacted ACTD officials at the Program Executive Office of the Air Base and Port Biological Program Office, Falls Church, Virginia; the Defense Information Systems Agency, Falls Church, Virginia; the Defense Advanced Research Projects Agency, Arlington, Virginia; the Defense Threat Reduction Agency, Fort Belvoir, Virginia; and the Defense Intelligence Agency, Arlington, Virginia.

To determine the factors that affected the transition outcomes of completed ACTD projects, we met with the operational and technical managers for each ACTD as well as other knowledgeable program officials and the designated ACTD representatives from each of the services. We compared information gathered on the individual ACTDs to discern those factors that were salient in a majority of the cases. In order to better understand ACTD program guidance, funding, and management that can affect transition outcomes, we spoke with relevant officials within the office of the Deputy Undersecretary of Defense, Advanced Systems and Concepts (DUSD (AS&C)), including staff responsible for funding and transition issues, and the Executive Oversight Manager for each ACTD. We also discussed ACTD management and transition issues with representatives of the DUSD (AS&C), Comptroller; the Joint Staff; and the Director, Defense Research and Engineering; the Defense Advanced Research Projects Agency; and the Defense Information Systems Agency. We did not conduct a detailed review of the users' acceptance or satisfaction with the items of the ACTD process.

We conducted our review between October 2001 and October 2002 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Chairmen and Ranking Minority Members of the Subcommittee on Defense, Senate Committee on Appropriations; the House Committee on Armed Services; and the

Subcommittee on Defense, House Committee on Appropriations; and the Secretaries of Defense, the Army, the Navy, and the Air Force. We are also sending copies to the Director, Office of Management and Budget. In addition, this report will be made available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have questions concerning this report, please contact me at (202) 512-4841. Others who made key contributions to this report include William Graveline, Tony Blieberger, Cristina Chaplain, Martha Dey, Leon Gill, and Nancy Rothlisberger.

Katherine V. Schinasi
Director, Acquisition and Sourcing Management

Appendix I: Technology Readiness Levels and Their Definitions

Technology readiness level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard. Validation in laboratory environment.	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond the breadboard tested for technology readiness level (TRL) 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and "flight qualified" through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system "flight proven" through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.

Appendix II: Comments from the Department of Defense

The Department of Defense provided written comments on a draft of our report. In a November 27, 2002, letter DOD modified its comments from "partially concur" to "concur" with our recommendation 1.

ACQUISITION, TECHNOLOGY AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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November 27, 2002

Ms. Katherine V. Schinasi
Director, Acquisition and Sourcing Management
U.S. General Accounting Office
441 G. Street, N.W.
Washington, DC 20548

Dear Ms. Schinasi:

This letter provides a modification to the enclosure of my letter dated November 14, 2002 which was the Department of Defense (DoD) response to the GAO Draft Report "DEFENSE ACQUISITIONS: Factors Affecting Outcomes of Advanced Concept Technology Demonstrations," dated October 29, 2002.

Based on our coordination and your modifications to the subject Draft Report, I have modified my response to Recommendation 1 from "partially concur" to "concur." My action officer for this effort is Mr. Ben Riley, (703) 602-06983, bcn.riley@osd.mil

Sincerely,

Sue C Payton

SUE C. PAYTON
Deputy Under Secretary of Defense
(Advanced Systems & Concepts)

ACQUISITION, TECHNOLOGY AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

November 14, 2002

Ms. Katherine V. Schinasi
Director, Acquisition and Sourcing Management
U.S. General Accounting Office
441 G. Street, N.W.
Washington, DC 20548

Dear Ms. Schinasi:

This is the Department of Defense (DoD) response to the GAO Draft Report "DEFENSE ACQUISITIONS: Factors Affecting Outcomes of Advanced Concept Technology Demonstrations," dated October 29, 2002 (GAO Code 120105).

The DoD has reviewed the draft report and partially concurs with Recommendations 1 and 3 and concurs with Recommendation 2. Specific comments for each recommendation are enclosed. My action officer for this effort is Mr. Ben Riley, (703) 602-0683, ben.riley@osd.mil

Sincerely,

SUE C. PAYTON
Deputy Under Secretary of Defense
(Advanced Systems & Concepts)

Enclosure

GAO DRAFT REPORT DATE OCTOBER 29, 2002
GAO CODE120105/GAO-03-52

"DEFENSE ACQUISITIONS: FACTORS AFFECTING OUTCOMES OF ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS"

DEPARTMENT OF DEFENSE COMMENTS TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense develop and require the use of criteria for assessing the military utility of the technologies and concepts that are to be demonstrated within each Advanced Concept Technology Demonstration (ACTD). The criteria should at a minimum identify measurement standards for performance effectiveness and address how results should be reported in terms of scope, format, and desired level of detail. (p. 17/GAO Draft Report)

DOD Response: Partially Concur. The Deputy Under Secretary of Defense for Advanced Systems and Concepts (AS&C) is working with, and will continue to work with, the participants of each ACTD to define, prior to the program initiation a clear set of measurement standards for performance effectiveness. This effort will also identify the appropriate reporting formats including scope and level of detail for these programs. These standards will be vetted with the appropriate Lead Service, User Sponsor and Transition Manager for each individual ACTD. Recognizing the range and variability of ACTDs and the topics they address, however, will make it difficult to develop a single measurement standard. The performance standards for each ACTD will be unique. However, it is critical that these standards be identified up front and that all ACTD participants be aware of them and their function as a key metric in defining the military utility of the components of each ACTD. Additionally, AS&C expanded partnerships with Service testing and evaluation centers during the demonstration process. These centers bring recognized expertise with military utility assessment processes and reports. Drawing on this experience, AS&C will develop assessment templates to methodically capture and catalog results of demonstrations.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense explore the option of requiring the Services and defense agencies to develop a category within their budgets specifically for ACTD transition activities, including procurement and follow-on support. (p. 17/GAO Draft Report)

DOD RESPONSE: Concur. The Deputy Under Secretary of Defense (Advanced Systems and Concepts) will, in coordination with the Under Secretary of Defense (Acquisition, Technology and Logistics) continue to coordinate with Services and defense agencies to develop funding strategies to support follow on transition and support of ACTD products which have demonstrated military utility during field exercises and actual operations. As an initial effort, the Deputy Under Secretary of Defense (Advanced Systems and Concepts) has adjusted the OSD funding contribution for execution of an

ACTD to focus on the first two years of the program. This, in theory, allows Services and defense agencies to adjust their out year Program Objective Memoranda and budgets to more adequately fund the latter portion of an individual ACTD.

RECOMMENDATION 3: The GAO recommended the Secretary of Defense require the lead service or defense agency obtain the concurrence of the Secretary's designated representative on any decision not to transition an ACTD that is based on joint requirements and determined to be militarily useful. (p. 17/GAO Draft Report)

DOD RESPONSE: Partially concur. The Deputy Under Secretary of Defense for Advanced Systems and Concept will enhance coordination with the Joint Staff in order to provide more comprehensive feedback on the performance of specific ACTDs and the merits of the ACTD components to enhance specific joint warfighting issues and requirements. Additionally the Under Secretary of Defense for Acquisition, Technology and Logistics currently conducts quarterly meetings with Service Acquisition Executives to review specific aspects of the ACTD program. This forum will be evaluated as a venue to bring forward issues regarding both the performance of and transition of specific ACTD programs and products.

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