June 14, 2002

Acquisition

Army Transition of Advanced Technology Programs to Military Applications
(D-2002-107)

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Acronyms

ACTD	Advanced Concept Technology Demonstration
AMC	Army Materiel Command
ATD	Advanced Technology Demonstration
S&T	Science and Technology
STO	Science and Technology Objective
TRL	Technology Readiness Level
TTA	Technology Transition Agreement

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
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June 14, 2002

MEMORANDUM FOR AUDITOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Audit Report on the Army Transition of Advanced Technology Programs to Military Applications (Report No. D-2002-107)

We are providing this report for review and comment. We considered management comments on a draft of this report when preparing the final report.

DoD Directive 7650.3 requires that all recommendations be resolved promptly. We request the Assistant Secretary of the Army for Acquisition, Logistics, and Technology provide additional comments to Recommendations A.1., A.2., A.3., and A.5. We also request that the Commander, Army Materiel Command provide comments to Recommendation B. Additional management comments should be received by July 15, 2002.

If possible, please provide management comments in electronic format (Adobe Acrobat file only). Send electronic transmission to the e-mail addresses cited in the last paragraph of this memorandum. Copies of the management comments must contain the actual signature of the authorizing official. We cannot accept the / Signed / symbol in place of the actual signature.

We appreciate the courtesies extended to the audit staff. For additional information on this report, please contact Mr. Bruce A. Burton at (703) 604-9071 (DSN 664-9071) (bburton@dodig.osd.mil) or Mr. Roger H. Florence at (703) 604-9067 (DSN 664-9067) (rflorence@dodig.osd.mil). See Appendix E for the report distribution. Audit team members are listed inside the back cover.

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Office of the Inspector General of the Department of Defense

Report No. D2002-107 **June 14, 2002**
(Project No. D2001AB-0105)

Army Transition of Advanced Technology Programs to Military Applications

Executive Summary

Who Should Read This Report and Why? Science and technology officials in the Office of the Secretary of Defense and the Department of the Army should read this report because it evaluates the Army's current process for enhancing the likelihood that emerging technology would reach the warfighter.

Background. Congress and DoD officials have voiced concern that technology has not quickly transitioned to the warfighter. A goal of the Department of the Army is to modernize its forces by introducing technology capabilities at a more rapid pace without incurring the need for additional funds. In October 1999, the Army announced its new Objective Force initiative to develop a more mobile and responsive force that is able to deploy troops anywhere in the world in a short period of time. To help achieve the objective, the Army had about 260 separate funded advanced technology projects or tasks from FYs 1999 through 2001, with an average aggregate funding level of more than $700 million to develop capabilities for introduction to military applications.

Results. Acquisition program officials were not adequately involved in fully facilitating and supporting the successful and timely transition to the warfighter. We reviewed 20 science and technology projects with expenditures of $441.5 million that included 6 advanced technology demonstration programs and 14 science and technology objective programs. Improvements were needed because:

- none of the 18 projects had formally agreed to technology readiness levels,
- five science and technology projects that were advanced technology demonstrators did not have acquisition program funding necessary for transitioning, and
- of two science and technology projects that transitioned with expenditures of $36.3 million, one did not meet the exit criteria before it transitioned and the other required substantial additional development by the receiving acquisition program office.

As a result, unless recommended measures are undertaken to effectively coordinate formal acquisition program support for the 18 science and technology projects that have planned additional funding of $244.4 million, the Army cannot make fully informed and prudent decisions on whether continued investment is warranted. See the Finding section for the detailed recommendations (finding A).

Management did not use the performance appraisal process effectively to assist in achieving DoD performance goals and the Army Materiel Command's corporate objective. Science and technology officials' management performance plans need to include technology transitioning as a performance element. See the Finding section for the detailed recommendations (finding B).

Management Comments. The Deputy Assistant Secretary of the Army (Research and Technology) commented on the draft report. We did not receive comments from the Commander, Army Materiel Command to the draft issued on February 25, 2002. The Deputy Assistant Secretary concurred with most of the recommendations and stated that the recommended policies had been put in place for advanced technology demonstrations programs; however, science and technology objective programs should not be held to the same standard because they are in earlier stages of development. He nonconcurred with reviewing technology paths for technologies included in the audit, stating that, by nature, those projects will not always be successful in transitioning to acquisition and only the most technically mature efforts should be planned for transitioning. The Deputy Assistant Secretary concurred with linking personnel performance plans to program performance and stated that the linkage should apply only to advanced technology demonstration managers and not to the less mature science and technology objective programs. Management comments are discussed in each finding and the complete text is included in the Management Comments section.

Audit Response. Management comments were generally nonresponsive. We believe that there is no significant difference between advanced technology demonstration and science and technology objective programs because both use advanced technology development funds. Based on the audit's results, the Army's policies for coordination are not being followed in all respects, and additional Army procedures for advanced technology development programs need to be issued. We request that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology and the Commander, Army Materiel Command provide comments to the final report. The comments should be received by July 15, 2002.

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Background

DoD Acquisition Policy. DoD Directive 5000.1, "The Defense Acquisition System," (Incorporating Change 1, January 4, 2001) October 23, 2000, states that science and technology (S&T) projects shall address user needs. Programs will be broad based, spanning all DoD S&T, to anticipate future needs and those technologies not being pursued by civil or commercial communities. The S&T projects will preserve long-range research and should enable rapid transition from the S&T base to useful military products. Specific S&T projects must focus on increasing the effectiveness of a capability, decreasing cost, increasing operational life, and improving the capabilities of systems through planned upgrades.

Science and Technology Guidance. An affordability task force chartered by the Director for Defense Research and Engineering issued a handbook and the Deputy Under Secretary of Defense (Science and Technology) issued a guide to the Military Departments and Defense agencies concerning practices that they believed, if instituted, would assist in transitioning technology. In addition, in response to congressional concerns that the DoD had not been successful in transitioning technology, the Under Secretary of Defense for Acquisition, Technology, and Logistics issued a report to Congress identifying why technology was not transitioning.

Addressing Affordability in Defense Science and Technology (S&T): A Handbook for S&T Managers. In October 1999, the DoD S&T Affordability Task Force issued a Handbook that stresses the importance of early involvement of all candidate acquisition programs in advanced technology efforts. The Handbook states that early involvement of advanced technology candidate acquisition programs in research development, design, test planning, manufacture, training, logistics, finance, and contracts are essential to address key issues that lock in a majority of the life-cycle costs of programs. The Handbook states that management tools for ensuring effective technology transitioning include establishing integrated product teams (known as IPTs), creating IPT charters, identifying quantitative metrics and key exit criteria, and developing a formal transition plan that is officially signed by the "customer" (usually an acquisition community member) and the technology manager. Additional management tools include preparing an approved memorandum of agreement or understanding that includes a funding strategy, which commits the acquisition community to transition the technology.

Technology Transition for Affordability: A Guide for S&T Program Managers. In April 2001, the Deputy Under Secretary of Defense (Science and Technology) issued a Guide to provide S&T program managers with strategies to transition technology to the acquisition community. The Guide states that the transition of technology should be timely (get the technology in the hands of the warfighter as soon as possible) and cost-effective (provide the best technology at the lowest possible cost). The Guide states that a key strategy for transitioning technology is early coordination between the S&T project manager and the receiving acquisition manager to promote a mutual understanding between the two parties. Early coordination assists the S&T project manager's understanding of how to transition the technology with the time-phased requirements of the receiving acquisition manager. The receiving acquisition manager, in turn, is kept current on the maturity of the technology and is

better able to plan and schedule the technology introduction. A tool for fostering this coordination is to establish IPTs that involve the managers of the candidate acquisition programs. The Guide provides that IPTs should include the S&T project manager, the S&T contractor, the acquisition manager and the respective contractor(s), and test and evaluation representatives. An IPT should be formed early in the life cycle of a technology's development to address key issues that can greatly affect life-cycle cost and the eventual acceptance and implementation of the technology. Issues that the IPT should address include defining and agreeing upon quantifiable metrics, such as cost, performance, and schedule; exit criteria; and the maturity of the technology at transition identified as technology readiness levels (TRLs) (the TRLs are described in Appendix B). The Guide states that those issues and others should be agreed upon in formal documentation such as memorandums of agreement or understanding and technology transition plans.

Under Secretary of Defense for Acquisition, Technology, and Logistics Report to Congress. In June 2001, the Under Secretary of Defense for Acquisition, Technology, and Logistics provided a report to the congressional defense committees on technology transition from the Defense Advanced Research Projects Agency. The report provided Congress with the results of a review of the transition of research to the Military Departments from the Defense Advanced Research Projects Agency and addressed issues that were also applicable for the Army transition of research technology to acquisition program managers and, ultimately, to the warfighter. The report cited a key reason for difficult technology transition as being the need for collaboration among three diverse groups: the S&T researcher, the acquisition program manager, and the military user. Effective transition requires the groups to work together as a team, which is frequently a difficult issue. In addition, for a technology transition to be successful, the acquisition program manager's prime contractor must be supportive of the technology insertion, and the technology must demonstrate a greater return than the existing capability.

Army S&T Process. The Army Science and Technology Master Plan (the Plan) presents the S&T investments that are required to achieve the Army vision of transforming its force's capabilities to dominate the full spectrum of operations. The Army vision is to create an Objective Force capable of deploying a combat brigade anywhere in the world in 96 hours, a combat division in 120 hours, and five combat divisions anywhere in 30 days. The Army S&T projects were reshaped to speed development of technologies necessary to achieve the Army's transformation vision. The transformation path from today's force to the future Objective Force includes incorporating technologies into existing and developing systems. The Army had about 260 separately funded advance technology projects or tasks from FYs 1999 through 2001, with an average aggregate funding level of more than $700 million per year to develop capabilities for introduction to military applications.

Objectives

The audit objective was to determine whether the Army was successful in transitioning advanced technology projects to military applications. Specifically, we examined whether the Army had established a process to successfully transition technology. We also evaluated management controls in the Army as they relate to the audit objective. See Appendix A for a discussion of the audit scope and methodology and the review of the management control program.

A. Army Science and Technology Process

The Army S&T management created an extensive management process in 1999 to plan, review, and provide oversight of technology efforts that were proposed to transition to the warfighter. However, improvements are still needed because acquisition program officials were not adequately involved in fully facilitating and supporting the successful and timely transition to the warfighter for 18 science and technology projects that had expenditures of $405.2 million.[1] For example, none of the 18 projects had formally agreed to technology readiness levels, which are agreed-upon levels of technology maturity development that are required for transitioning to the receiving acquisition program manager. Also, five of the science and technology projects, which were advanced technology demonstrators, did not have the necessary acquisition program funding for transitioning. Finally, for the two science and technology projects that transitioned with expenditures of $36.3 million, one did not meet the exit criteria before it transitioned and the other required substantial additional development by the receiving acquisition program office. Acquisition program officials were not adequately involved in transitioning technologies because the Army S&T management process did not require the level of coordination between acquisition officials that was advocated in the Deputy Under Secretary of Defense (Science and Technology) guidance. Specifically, integrated product teams were not established or they did not include acquisition program managers, the S&T manager did not establish formal agreements with acquisition program managers that included technology readiness levels and exit criteria, and S&T projects were not budgeted by acquisition users to transition. As a result, unless measures are undertaken to effectively coordinate the 18 science and technology projects that have planned additional funding of $244.4 million, the Army cannot make fully informed and prudent decisions on whether continued investment is warranted.

Army Science and Technology Review Process

Army S&T Review Process. The S&T community has an extensive technology planning, review, and oversight process to assist the Army in achieving the future Objective Force. The Army Pamphlet 70-3, "Army Acquisition Procedures," July 15, 1999, (Army guidance) describes the S&T review process and provides discretionary guidance on S&T projects. At the beginning of each fiscal year, the Deputy Assistant Secretary for Research and Technology and the Director, Force Development Office of the Deputy Chief of Staff for Programs, issue guidance on new technology proposals and existing technology reviews.

[1]A total of 20 science and technology projects were reviewed with expenditures of $441.5 million.

New technology proposals are identified as S&T objectives (referred to in the Army as STOs) and are reviewed and approved during Army's annual S&T oversight process. The annual S&T oversight process also reviews ongoing technology projects[2] that have been in development for 3 years; that have been revised in terms of cost, schedule, or scope; and that have been completed.

The Army S&T Program received management direction and approval from three executive-level groups in developing the Plan. The first level of review is the Warfighter Technical Council, a one-star-level group that performs detailed reviews of all proposed and ongoing STOs, advanced technology demonstrations (ATDs) and advance concept technology demonstrations (ACTDs). The Warfighter Technical Council is co-chaired by the Director of Technology, Office of the Deputy Assistant Secretary for Research and Technology, and the Assistant Chief of Staff for Combat Development, Army Training and Doctrine Command. The Training and Doctrine Command represents the military user in identifying and supporting areas for S&T research. The second level of review is the Army S&T Working Group, co-chaired by the Deputy Assistant Secretary for Research and Technology and the Assistant Deputy Chief of Staff for Programs (Force Development). The Army S&T Working Group provides two-star-level resolution of issues and reviews and approves research efforts for STOs and ATDs. The Army's final approval level is the S&T Advisory Group, a four-star-level group that is co-chaired by the Assistant Secretary of the Army for Acquisition, Logistics, and Technology and the Army Vice Chief of Staff. Army acquisition representation is provided at all three reviews. Appendix C provides a flow chart depicting the Army S&T oversight process.

Technology Project Documentation. As part of the S&T review process, S&T project managers are required to submit documentation providing an overview of proposed and ongoing projects. The required documents include a project description chart, a product description chart, TRLs and a milestone chart, and the Ten-Question Quad Chart. Those four documents are used as a basis for determining whether or not a proposed effort becomes a STO, ATD, or ACTD. The project description chart provides the program objective and identifies intermediate milestones and final product applications (with metrics) to Army systems. The product description chart identifies the program's technologies and provides additional STO information such as affordability metrics and approval dates for the Mission Needs Statement or the Operational Requirements Document. The TRL milestone chart provides the TRLs for the technologies as well as the significant high-level metrics that will be achieved throughout the duration of the technology development. The Ten-Question Quad Chart identifies the purpose of the research, the technology barrier to be overcome, the quantitative metrics to be met, the TRLs to be achieved, the estimated timeframes for the technology to be available, and the office or acquisition program that endorsed the research effort.

[2]Other technology efforts include ATDs and ACTDs.

Ten-Question Quad Chart. The annual oversight process uses the Ten-Question Quad Chart as one of the key documents to evaluate proposed and ongoing S&T projects. The Ten-Question Quad Chart provides the data necessary to evaluate the merits of the technology and is divided into four discrete sections.

The first section describes the problem, the barriers to solving the problem, and the plan to overcome the barriers. The second section discusses how the S&T project fits into Army needs, ongoing and completed S&T capabilities, and lists TRLs. The third section provides the benefits of the S&T project in terms of increased capability and cost savings, the transition milestones, the candidate acquisition programs or S&T projects to receive the technology, and the office that endorsed the research. The final section provides the schedule and the cost of major tasks.

The Army requires that all S&T projects have a technology path or plan that identifies the candidate programs for the transitioning technology in the Ten-Question Quad Chart. Our review of the Ten-Question Quad Chart identified that it does not accurately portray the technology transition paths or plans. For example, the Aviation and Missile Command, Aviation Applied Technology Directorate, planned seven STOs or ATDs for aviation platforms. According to the Ten-Question Quad Chart, four of the STOs or ATDs identified five candidate aviation platforms for the developing technology, with plans for three of those platforms to transition from FYs 2002 through 2004. However, the receiving acquisition program managers stated that they had not planned, scheduled, or budgeted for the technology introduction. The acquisition program managers stated that they were monitoring the STO or ATD technologies and that when they believed the technologies were mature, they would consider introducing the technologies to the aviation platform during a scheduled platform upgrade. The introduction would occur if the funding was available and if the technology was a sufficient upgrade to warrant the expenditure. The following are two examples of ongoing technologies that lack formal acquisition program support.

Helicopter Active Control Technology STO. The Helicopter Active Control Technology STO was proposed to demonstrate a 60-percent improvement in weapon pointing accuracy, a 50-percent increase in agility and maneuverability, and a 30-percent reduction in flight test time. The STO Ten-Question Quad Chart showed that the S&T was scheduled to transition to the Chinook helicopter (CH-47) upgrade in FY 2003, the Blackhawk helicopter (UH-60) upgrade in FY 2006, and the Apache helicopter (AH-64) upgrade in FY 2007. Although the technology was planned to be demonstrated on the Apache helicopter, the acquisition program managers for the Chinook, Blackhawk, and Apache had not prepared detail plans or budgets for the technology to be added to their helicopter systems.

Advanced Rotorcraft Transmission II. The Advanced Rotorcraft Transmission II STO goals were to demonstrate a 25-percent increase in drive system power-to-weight ratio, a 10-percent reduction in drive system operating cost, and a 10-decibel reduction in transmission-generated noise. The Advanced

Rotorcraft Transmission II development effort was conducted on the Osprey tilt-rotorcraft (V-22), a non-Army helicopter. The Ten-Question Quad Chart for the Advanced Rotorcraft Transmission II identified the Blackhawk helicopter (UH-60X) in FY 2006, the Comanche helicopter (RAH-66) in FY 2006, the Apache helicopter (AH-64) in FY 2004, and the Osprey tilt-rotorcraft (V-22) in FY 2003 as candidate programs for the technology. However, none of the Army acquisition program managers had prepared detail plans or budgets for the technology to be added to their helicopter systems.

Although the S&T annual oversight process includes representatives from the user community (the Army Training and Doctrine Command) and the acquisition community (the Army Deputy for Systems Management and Horizontal Technology Integration), coordination with the specific receiving acquisition program managers is not required, and therefore makes the candidate acquisition systems identified in the Ten-Question Quad Chart questionable. To improve the merits of the Ten-Question Quad Chart and to enhance the likelihood of technology transition, the S&T project manager should be required to establish and maintain an up-to-date formal agreement with the candidate acquisition programs that are identified in the Ten-Question Quad Chart. The establishment of a formal agreement should be a condition for continued S&T funding.

Army Science and Technology Projects Reviewed

The audit examined 20 S&T projects funded with research, development, test, and evaluation funds; advanced technology development appropriations expenditures of $441.5 million and planned additional funding of $244.4 million at the two Army sites visited. The 20 S&T projects included 14 STOs and 6 ATDs at either the Tank-automotive and Armament Command, Armament Research, Development, Engineering Center; or the Aviation and Missile Command, Aviation Applied Technology Directorate.

The audit evaluated the 20 S&T projects and the extent of program coordination, using the Handbook and Guide, with the planned receiving acquisition program(s) or other technology effort. The Handbook and Guide cited best business practices include the creation of integrated product teams that are accompanied by an established charter. To be effective, the IPTs must include the acquisition program manager(s) and the prime contractor to facilitate the technology integration. The Handbook and Guide also provide for the formal establishment of memorandums of agreement or understanding with the acquisition program manager(s), including agreements on TRLs and exit criteria, and for coordination to provide acquisition programs with the necessary funding to continue the S&T integration. The following table summarizes the audit results by the STOs and the ATDs. See Appendix D for a summary of the advanced technology development projects that we reviewed.

Summary of Science and Technology Objectives (STOs) and Advanced Technology Demonstrations (ATDs) Examined
(ratio shows positive responses to total examined)

Action	Number of Occurrences 14 STOs	Number of Occurrences 6 ATDs	Percent of Occurrences 14 STOs	Percent of Occurrences 6 ATDs
Integrated Product Team				
Team established	7 of 14	6 of 6	50	100
Charter approved	3 of 7[3]	4 of 6[3]	43	67
Acquisition program manager included	9 of 16[4]	4 of 11[4]	56	36
Acquisition program prime contractor included	7 of 16[5]	5 of 11[5]	44	45
Acquisition Program Manager				
MOA/MOU	3 of 29[6]	2 of 11[6]	10	18
Exit TRLs formally agreed	0 of 26[7]	0 of 3[7]	0	0
Exit criteria formally agreed	1 of 29[6]	2 of 11[6]	3	18
Funding by acquisition user to transition	4 of 20[8]	0 of 6[9]	20	0

[3]Charters were established for projects that had IPTs.

[4]S&T projects that established IPTs applied to more than one existing acquisition program.

[5]S&T projects that established IPTs applied to more than one existing acquisition program prime contractor.

[6]The 14 STOs and 6 ATDs applied to 29 and 11 existing acquisition programs, respectively.

[7]Two STOs that applied to three acquisition programs and two ATDs that applied to eight existing acquisitions programs were completed before the requirement for TRLs.

[8]The number of STOs that should have had funding was 20 instead of 29 because for 9 STOs funding documentation was unavailable, the technology was a manufacturing improvement, or the user had not been defined.

[9]The number of receiving acquisition programs for ATDs that should have had funding was 6 instead of 11 because Aviation Applied Technology Directorate officials stated that, for five programs, only pieces of the Rotocraft Pilots Association technology were to transition.

Integrated Product Teams

DoD Instruction 5000.2, Operation of the Defense Acquisition System, (Including Change 1), January 4, 2001, requires that all S&T and acquisition programs establish IPTs. The DoD Instruction states that IPTs are a multifunctional team assembled around a product or services, and are responsible for advising the S&T project manager and acquisition program manager on cost, schedule, and performance of that product. Army acquisition procedures state that IPTs are a management technique that integrates all activities, from product concept through production and field support.

Integrated Product Teams Established. The establishment of IPTs was required for all the STOs and ATDs; however, despite guidance in the Handbook and the Guide, only 7 of 14 STOs established IPTs. All six ATDs that we reviewed had established IPTs. The Army S&T guidance does not require IPTs for STOs, but does require IPTs for ATDs.

Integrated Product Team Charters. In addition to the establishment of IPTs, the Handbook and Guide recommend that charters be established for the teams. The Handbook states that IPT charters provide the best way to minimize team misunderstanding. The Handbook and Guide provide that each charter should include:

- The mission and objectives of the team,
- The metrics to evaluate the team's progress,
- The scope of the team's responsibility,
- The relationship of the team with other teams,
- The authority and accountability of the team,
- The resources available for the team, and
- A team membership list.

For the seven STOs that established IPTs, three had approved charters, and four of the six ATDs had approved charters. The Army S&T guidance does not require the establishment of charters.

Acquisition Program Manager and Prime Contractor. One goal of the Army S&T Program is to transition technology to an acquisition program and, subsequently, to the warfighter. To transition technology faster, at reduced cost, and ensure interoperability with existing and future warfighting systems, the IPT should include the receiving S&T project manager and the receiving acquisition program manager's prime contractor, as appropriate. For the 7 STOs that established IPTs, 16 acquisition programs or S&T projects were identified as candidates to receive the technology. However, only 9 of the 16 acquisition programs or S&T project management offices and only 7 of the

16 prime contractors were members of IPTs. For the 6 ATDs that established IPTs, 11 acquisition programs or S&T projects were identified to receive the emerging technology. The 11 acquisition programs or S&T projects had 5 prime contractors participating (some programs had duplicate contractors). For the 6 ATDs, only 4 of 11 acquisition programs or S&T project management offices participated in the integrated teams. Also, only 5 prime contractors associated with the 11 acquisition programs were represented as members of the ATD integrated teams. The Army S&T guidance does not require the inclusion of acquisition program officials or their prime contractors in IPTs for STO or ATD efforts.

Role of Acquisition Program Managers

To improve the success of technology transitioning, acquisition program managers must make a firm commitment to transition the technology to their programs. The commitment should include a formal and up-to-date memorandum of agreement or understanding between the S&T project manager and the acquisition program manager(s). Each agreement or understanding should specify the relationship and the respective responsibilities of the S&T project manager and the receiving acquisition program manager. The agreement should address system requirements, funding, personnel support, exit criteria, and TRLs.

Memorandums of Agreement or Understanding. The 14 STOs identified 29 existing acquisition programs or S&T projects to which they could transition their technology. Formal memorandums of agreement or understanding between the STO managers and the receiving acquisition programs or S&T projects were available for only 3 of the 29 existing acquisition programs or S&T projects. The 6 ATDs identified 11 existing S&T projects or acquisition programs for technology transition; however, only 2 memorandums of agreements were established. Army guidance does not require memorandums of agreement or understanding.

Technology Readiness Levels. DoD adopted TRLs in response to a General Accounting Office Report, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, issued in July 1999, and mandated within the Army S&T community in early 2000. The TRLs are an assessment of the technical maturity for an S&T project. The TRL ratings range from one through nine, with more mature S&T efforts having a higher TRL number and a lower risk for the acquisition program.

Although TRLs were established for all S&T projects, they were not negotiated and formally agreed upon with the acquisition program managers or other S&T project managers. For the 14 STOs, 26 candidate acquisition programs or S&T projects to receive the emerging technology were identified. For the six ATDs, three acquisition programs or S&T projects were identified as potential receiving candidates. However, none of the 14 STO projects or the 6 ATDs established formal agreements with the receiving candidates on the TRL that the technology would be developed to prior to transitioning. Army guidance does not require formal agreements on TRLs between the S&T project manager and

the receiving candidate. As part of the overall coordination process, the S&T project manager and the receiving candidate should be required to formally agree on the TRL to enhance technology transitioning.

Exit Criteria. The exit criteria establish goals for S&T projects and determine the entrance criteria for the technology that transitions. The S&T project manager and the acquisition program manager, in collaboration with the IPT, should develop exit criteria that are appropriate for transitioning the technology. Exit criteria are used to track progress in technical, schedule, and management-risk areas. The 14 STOs identified 29 candidate acquisition programs or S&T projects, and the 6 ATDs identified 11 candidate acquisition programs or S&T projects. However, only one STO and two ATDs formally coordinated the exit criteria with the acquisition program manager or S&T project managers.

Army guidance does not require S&T project managers to establish formal agreements with acquisition program managers or other recipient S&T efforts on TRLs or exit criteria. The Army should establish a requirement for formal agreements with all planned technology recipients for continued funding.

Funding By Acquisition User for Transition

The DoD and the Services' research, development, testing, and evaluation budget is divided into seven budget activities. The S&T community receives funding from only the first three budget activities: basic research, applied research, and advanced technology development. The acquisition community is funded with three of the last four budget activities: demonstration and validation, engineering and manufacturing development, and operational systems development. The last budget activity, management support, is directed toward support of installations or operations required for general research and development use. S&T projects are not funded from the budget activity fund appropriated for the acquisition community, and acquisition programs are not funded from the budget activity fund appropriated for the S&T community. The separation of research, development, testing, and evaluation funding between the S&T and acquisition communities and the shrinking of the research, development, testing, and evaluation budget makes coordination between the S&T project managers and acquisition program managers very critical. If STOs and ATDs are critical to future and existing weapon systems, and the technology is successfully demonstrated using coordinated exit criteria and TRLs, the acquisition community must set funds aside for transitioning.

This review identified that receiving acquisition program managers were not providing the funding necessary for technology to transition. The 14 STO and 6 ATD projects evaluated were all funded from the Advanced Technology Development budget, generally through the final demonstration of the technology. However, only 4 of the 20 candidate acquisition program managers for the 14 STOs and none of the 6 candidate acquisition program managers for the 5 ATDs that were scheduled to receive technology had set aside funding to continue development after the technology transitions (1 ATD had 2 acquisition program candidates).

Formal agreements between the S&T project manager and the acquisition program manager as a requirement for continued S&T funding may highlight projects that are not likely to transition because the acquisition program manager had not adequately budgeted for the technology transition. Without adequate funding for technology transitioning, the S&T community will not be able to determine whether continued investment in S&T project is beneficial.

Recent Initiatives and Changes

The DoD and the Army recognized that technology has not transitioned to the warfighter as desired. To enhance the prospects of technology transitioning, DoD proposed establishing formal technology transition agreements, and the Army established Director(s) positions within the program executive offices to enhance technology transitioning.

Technology Readiness (Transition) Agreements. The Deputy Under Secretary of Defense (Science and Technology) issued interim guidance on July 5, 2001, that proposed the use of a Technology Readiness (Transition) Agreement. The Agreement would represent agreements between the S&T project managers and the candidate acquisition program managers for the emerging technology. The S&T project manager would provide a description of the technology or capability, the status of the technology, the technology development strategy, key technical measures of the readiness to transition, and the project plan, including milestones in the Agreement. The Agreement would also require the acquisition program manager to provide a description of the acquisition program, the program technology needs, and an integration strategy for the new technology. The S&T project manager and the acquisition manager would sign the Agreement and review it periodically. The Deputy Under Secretary of Defense (Science and Technology) did not require the establishment of an Agreement, and its use is advisory.

Army Reorganization. On October 26, 2001, the Army Chief of Staff reorganized the program executive officer and the program manager structure. The action abolished the positions of the Deputies for System Acquisition, Aviation and Missile Command, the Tank-automotive and Armaments Command, and the Communications Electronics Command and realigned their functions and assigned projects and acquisition program managers to existing, reorganized, or newly created program executive offices. The reorganization established a Director for Science and Technology (Director) in each program executive office. The Directors will be responsible for transitioning projects to the acquisition community from the Army S&T community. The details of the reorganization had not been determined; however, the Directors will be responsible for management and oversight of selected advanced technology development funding allocated for S&T activities. The Assistant Secretary will determine the amount of S&T funding that the Directors for Research and Technology will receive.

Management General Comments to the Report and Audit Response

Management Comments. The Deputy Assistant Secretary (Research and Technology) (the Assistant Secretary) stated that the role of the S&T community is to provide near-term capability and far-term focus for the future. It is the responsibility of the S&T community to bring technology options to the table. Once the technology has shown an appropriate level of maturity, the S&T managers negotiate with acquisition program managers to identify appropriate transition points. When the acquisition program manager determines that the technology is needed and can meet the program schedule, the acquisition manager will seek transition funding.

The report does not address the primary role of all of S&T efforts, which is to deliver options to the warfighters so that they can choose the best approach available at the time needed. It is critical that the S&T community be allowed to do exploration prior to discovery . . . to look at problems with an open solution set, vice a pre-determined path. The ability to keep the options open is the main reason for not requiring transition funding for all S&T efforts. The Army has implemented recommendations from the General Accounting Office Report "Better Management of Technology Development can Improve Weapon Systems Outcomes." The General Accounting Office recognized that the S&T organization has the responsibility to mature technology to high TRLs, hence adoption of TRLs as a key indicator of maturity. The General Accounting Office report indicated that the DoD S&T community is responsible for producing generic rather than weapon-specific technologies. Its goal is to conduct research, develop technology, and farm those efforts for potential military applications. The S&T role is to show that the technology is feasible; however, transition is not the sole purpose. The purpose of STOs and ATDs is to focus on technologies needed by the warfighter. The S&T community will transition technology if the Army decides that it needs this capability and has funds for its acquisition.

The management comments also provided information on some technology transitions and coordination actions that have taken place since the audit. Management comments included actions taken to establish TTAs with acquisition program managers (Blackhawk, Chinook, Apache, and the Comanche program offices) receiving research from the Aviation and Missile Research, Development, and Engineering Center and represent roadmaps for technology consideration.

Audit Response. Both new and ongoing S&T efforts are spending limited advanced technology demonstration resources. Technologies should have a more defined path for transitioning with formal transitioning agreements with the acquisition community if the Army's goal of achieving the future Objective Force is to be met. DoD adopted TRLs in response to a General Accounting Office report and with the desire that the establishment of TRLs would represent an agreement between the S&T and acquisition communities. By establishing

coordination between the two communities, evolving technology in the S&T community would do more than provide options to the warfighter; it would provide the technology capabilities to the warfighter.

Recommendations, Management Comments, and Audit Response

A. We recommend that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology, for advanced technology development efforts:

1. Require the establishment of integrated product teams that include representatives from the candidate acquisition program office(s) and the acquisition program office prime contractor(s), where appropriate.

Management Comments. The Assistant Secretary concurred and stated that the Army currently requires IPTs that involve acquisition and S&T managers for ATDs, but that it would be neither appropriate nor practical for each STO to have an IPT. STOs are programs of lesser maturity than ATDs and, even when successful, require further development before creation of an IPT and transition to acquisition would be appropriate.

Audit Response. Although management concurred, the comments are nonresponsive to the recommendation and conflict with the data in this report. As identified in the table in this report "Summary of Science and Technology Objectives (STOs) and Advanced Technology Demonstrations (ATDs) Examined," (page 8), all the ATDs had IPTs; however, only 4 of 11 acquisition managers were included in the IPTs for the ATDs. To enhance the involvement of the acquisition community in evolving technologies, the S&T managers should be required to establish IPTs that include the candidate acquisition program office(s) and their prime contractor(s). The Department of the Army Pamphlet 70-3, "Army Acquisition Procedures – Research, Development, and Acquisition," July 15, 1999, provides guidance in the management of S&T programs and the establishment of IPTs; however, the guidance is advisory and, as such, does not require the establishment of IPTs. The pamphlet states, "this pamphlet provides discretionary guidance on materiel acquisition management," and continues the advisory theme by stating, "the fundamental purpose of this version of Department of the Army Pamphlet 70-3 remains the same; provides advisory guidance on the materiel acquisition life cycle."

The Assistant Secretary stated that establishing IPTs for every STO would be neither appropriate nor practical. The Army makes a distinction between STOs and ATDs even though STOs and ATDs are both S&T projects using advanced technology development funds under the Research, Development, Test, and Evaluation appropriation. Additionally, STOs comprise 46 percent of the Army's advanced technology development budget for FY 2002 and have specific, measurable, major technological advancements to be achieved. Those advancements focus and stabilize advanced technology development efforts. Projects under this category have a direct relevance to identified military needs, and their development is used to demonstrate the general military use. As such,

early coordination with the potential recipient acquisition program is necessary to enhance the transition of the STO technology. The Army's review process requires the identification of weapon programs that STO technology would transition to as a requirement for STO approval and funding. Early coordination with potential acquisition recipients is emphasized not only in the Handbook and Guide, but also in the Defense Systems Management College course, "Technology Insertion in Defense Systems Acquisitions." The Handbook, the Guide, and the technology insertion course do not advocate lesser coordination for S&T efforts that use advanced technology development funds. The audit identified that half of the STOs examined had established IPTs, and that half of those IPTs included representatives from the acquisition community.

Accordingly, STOs should be consistently held to the same level of development coordination as the ATDs. We request that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology reconsider his position on requiring the establishment of IPTs for ATDs and STOs and provide additional comments to the final report.

2. Require the establishment of formal agreements between the science and technology manager and the candidate acquisition program manager(s) for emerging technologies. The formal agreements should coordinate exit criteria, technology readiness levels, availability of transitioning funds, and estimated transitioning timeframes.

Management Comments. The Assistant Secretary concurred and stated that ATD management plans are approved for all ATDs and document exit criteria, TRLs, and estimated transition time frames. The signed ATD management plans serve as the MOA or MOU between the S&T community and the acquisition manager.

Audit Response. Although management concurred, the comments are nonresponsive and conflict with the data in this report. The audit examined ATD management plans and considered them in developing the audit results. The audit results for ATDs (page 8) contradict management's comments that formal agreements have been appropriately established. Management comments also exclude applicability to STOs. As presented in the audit response to Recommendation 1., formal agreements are needed for STOs as well as ATDs.

Further, the DoD has been placing greater emphasis on coordinating advanced technology demonstration-funded efforts to improve technology transitioning. The Deputy Under Secretary of Defense for Science and Technology, in a July 5, 2001, memorandum to the Military Departments and Defense agencies, recommended the development of TRLs and, unlike the Army, made no distinction between emerging technologies. Accordingly, we request that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology reconsider his position and provide comments to the final report on the deficiencies identified in the report and on requiring formal agreements for all ongoing STOs as well as ATD efforts.

3. Require the establishment of formal memorandums of agreement or understanding and technology transition agreements between the science and technology manager and candidate acquisition program manager(s). The establishment of the formal agreements should be a requirement for continued research, development, test and evaluation funding.

Management Comments. The Assistant Secretary concurred and stated that Army's ATD management plans serve as formal MOAs/MOUs and as TTAs.

Audit Response. Although management comments concurred, the comments were not fully responsive to the recommendation. The comments excluded applicability to STOs. Therefore, we request the Assistant Secretary of the Army for Acquisition, Logistics, and Technology to provide comments to the final report that address applicability to STOs.

4. Require the participation of the program executive officer and the acquisition program manager in the Army science and technology annual review process. The program executive officer and acquisition program manager should review and formally comment on the feasibility of science and technology projects that are integrating and transitioning into acquisition programs.

Management Comments. The Assistant Secretary concurred and stated that action is underway to include the program executive officer in the Army Science and Technology Working Group that approves all STOs and ATDs.

Audit Response. Management comments were responsive to the recommendation.

5. Review the technology paths or plans for the 18 science and technology projects identified in this audit and discontinue any project that does not have formal acquisition program support.

Management Comments. The Assistant Secretary nonconcurred and stated that S&T examines the feasibility of technology to solve warfighter problems, and that only the most technically mature efforts in the advanced technology development program should be considered and planned for transitioning. The General Accounting Office criticized the Services for attempting transitions when technology was immature.

The Assistant Secretary stated that the nature of S&T in relation to acquisition has three phases; basic, applied, and advanced technology development. Basic research is discovery and understanding, trying to expand the knowledge. Basic research does not directly transition to acquisition. Applied research can be repeated, shows military utility, and can be further evaluated in the most mature technology environment-- advanced technology development. Advanced technology development has the highest probability of providing transitionable products. Within advanced technology development, the Army has three broad categories of activity; ATDs, STOs, and other advanced technology efforts (referred to by the Army as non-STOs). ATDs are the most complex efforts and have the closest link to acquisition programs. STOs are typically less

complex and their ability to transition is based upon Army funding priorities and warfighting requirements. Whether STOs transition or not, they remain valuable "proof" of technology concepts and capabilities. The remaining advanced technology efforts (non-STOs) are used to pursue higher risk technology and have a lower probability of transitioning.

Audit Response. Management comments were nonresponsive and do not address the intent of the recommendation. We understand the distinction between basic and applied research and we did not include S&T efforts in those early stages in this audit. We agree that immature technology should not transition and believe that strengthening coordination between the S&T and acquisition community, including formally agreeing to TRLs and exit criteria, would significantly reduce problems in this area.

The report of the Under Secretary of Defense for Acquisition, Technology, and Logistics to Congress, in June 2001, cited a key reason for difficult technology transitions was the need for collaboration among three diverse groups: the S&T researcher, the acquisition program manager, and the military user. The Under Secretary's report stated that effective transitions require the groups to work together as a team, which is frequently a difficult issue. Management comments ignore the results of this review summarized in "Summary of Science and Technology Objectives (STOs) and Advanced Technology Demonstrations (ATDs) Examined," (page 8) that improvements are needed for two members of this diverse group.

The Army requires advanced technology development efforts, ATDs, and STOs to identify transitioning plans or paths as described in the Army Science and Technology Review Process (page 4). The process requires technology project documentation including the Ten-Question Quad Chart that identifies the planned acquisition program for the emerging technology. This audit examined the coordination efforts from Army's Ten-Question Quad Chart between the S&T community and the identified acquisition program offices. With limited S&T financial resources, it would be prudent for management to align S&T efforts in areas that are more likely to result in a successful transitioning of the technology to the warfighter. The intent of the recommendation, based on the lack of coordination among two of the diverse groups, was to examine those efforts that do not have adequate coordination as recommended in the Handbook, the Guide, and Defense Systems Management College training. We believe that continued expenditure of advanced technology demonstration funds without the proper coordination for technology efforts is inappropriate and ignores lessons learned. Therefore, we request that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology reconsider his position and provide additional comments to the final report.

B. Performance Assessments

The performance appraisal process was not effectively used as a management tool to assist in achieving DoD performance goals and the Army Materiel Command's corporate objective of transitioning technology quickly to the warfighter. This condition exists because the Centers did not incorporate performance goals necessary for successful technology transitioning into the S&T project managers' performance plans. As a result, the Army Materiel Command's Research, Development and Engineering Centers (Centers) were not fully applying the Deputy Under Secretary of Defense (Science and Technology) best practices and Army guidance on managing and coordinating the transition of technology.

Background

Deputy Under Secretary of Defense (Science and Technology). The Deputy Under Secretary of Defense (Science and Technology) issued a Handbook followed by a Guide to the Military Departments and Defense agencies concerning practices that he believes, if instituted, would assist in achieving the DoD goal for transitioning technology.

Addressing Affordability in Defense Science and Technology (S&T): A Handbook for S&T Managers. In October 1999, the DoD S&T Affordability Task Force issued a Handbook that stressed the importance of involving all candidate acquisition programs; that is, the acquisition program managers, in developing research. The Handbook emphasized that effective transitioning of technology should include establishing IPT groups, creating an IPT charter, identifying and agreeing to quantitative metrics and key exit criteria, developing formal transition plans, and developing memorandums of agreement or understanding. The Handbook stressed that, through the establishment of working groups and agreements with all candidate acquisition programs such as the receiving program office and the user, evolving technology has a better chance of transitioning.

The Handbook also stated that one of the keys to successful transitioning is implementing an S&T personnel assessment process that is based on transitioning and affordability, in addition to technical personal achievement and papers.

Technology Transition for Affordability: A Guide for S&T Program Managers. In April of 2001, the Deputy Under Secretary of Defense (Science & Technology) issued a Guide to provide S&T project managers with strategies for achieving technology transitioning. The Guide emphasized the importance of teaming with the customer; that is, the acquisition program manager. The Guide stated that, although S&T projects are viewed as pre-acquisition, S&T inclusion in the new acquisition policy (DoD Instruction 5000 and DoD 5000.2-R) should serve to focus resources on improving transitioning. The implementation of the new acquisition policy that includes S&T in the

acquisition process will yield increased connectivity, visibility, and communication among the S&T community, the acquisition community, and the user, all of which are important for effective transitioning.

Army Materiel Command's Strategic Plan. The Army Materiel Command (AMC) issued its strategic plan in July 2001. The AMC Strategic Plan identifies eight strategic goals as instrumental to the AMC and the Army's successful transformation outlined in the Army vision. To accomplish the 8 strategic goals, the AMC promulgated 14 objectives. Three of the AMC objectives include developing and implementing an AMC corporate S&T capability to integrate all organizations and disciplines in support of the Army transformation; developing and implementing processes to rapidly acquire and field the best technology to transform the force and enhance survivability, lethality, deployability and affordability; and developing and implementing a process to transition technology to materiel developers (acquisition program managers) in a timely manner. The AMC Strategic Plan provides a framework to build the AMC of the future and stresses that its success requires a total commitment from every leader, manager, and associate. The AMC Strategic Plan also requires each AMC element to develop a corresponding plan with goals, objectives, and metrics that are closely aligned to the framework of the AMC Strategic Plan.

Project Manager Performance Plans

Major Subordinate Commands and Personal Performance Objectives. On September 12, 2001, the Commander, AMC, issued a memorandum reiterating that major subordinate commands are required to prepare their Strategic Plans and Command Objectives in consonance with the AMC Strategic Plan. The AMC memorandum also required that major subordinate commands link every senior leader's performance plan, down to the division level, to the objectives of the major subordinate commands.

The personal performance plans obtained for S&T project managers at the Armament Research, Development, and Engineering Center of the Army Tank-automotive and Armament Command; and the Aviation Applied Technology Directorate of the Army Aviation and Missile Command, did not include adequate S&T performance requirements necessary to enhance technology transitioning.

Armament Research, Development and Engineering Center. Examination of performance plans for S&T project managers identified that the managers are responsible for technical program management, engineering design and support, financial management, and training and security.

Technical program management responsibilities include planning, scheduling, and coordinating all major activities related to the S&T project; conducting

briefings on S&T tasks; attending and participating in meetings and conferences; overseeing test plan preparation; coordinating and witnessing tests; and conducting special projects or tasks involving planning, control, analysis, and execution.

Engineering design and support responsibilities include providing engineering support; providing guidance on follow-on design efforts; and preparing requirements to software contractors.

Financial management responsibilities include developing funding requirements and expenditure plans; reviewing funding performance; and maintaining expenditures within financial guidelines.

Training and security focused on obtaining training and being aware of and complying with security procedures.

None of the plans discussed performance requirements in relation to transitioning S&T projects to acquisition programs. The incorporation of this performance element in S&T project managers' performance appraisals would emphasize the importance of transitioning technology.

Aviation Applied Technology Directorate. The review of S&T project managers' performance plans at the Aviation Applied Technology Directorate showed that the technical personnel were responsible for project planning, project execution, professional development, and team leadership.

Project planning functions include planning realistic and executable schedules within budget constraints; identifying mission needs and deficiencies; coordinating efforts vertically and horizontally with other organizations; developing project plans, including need, technology feasibility, cost estimates; developing, evaluating, and negotiating contract work efforts, engineering specifications; and developing contract data requirements.

Project execution responsibilities include maintaining cognizance and responsibility for execution of assigned S&T projects so that technical cost and schedules are quantifiable and commensurate with project plans; identifying project perturbations and taking timely corrective actions; ensuring proper expenditure of funds; and satisfying customers (internal and external).

Professional development and team leadership include maintaining technical competence and cultivating professional and personal growth of team personnel.

The inclusion of project planning, project execution, professional development, and team leadership are all important performance elements for the S&T project managers. The inclusion of a performance element concerning technology transition would help highlight that proven technology must transition to the warfighter.

Performance Assessments. Although the S&T project managers' performance attributes identified at the Center and the Directorate are valuable in executing S&T projects, the S&T project managers are not required to establish and

maintain the necessary attributes for coordination and technology transitioning identified in the Deputy Under Secretary of Defense (Science and Technology) Handbook and Guide.

As identified, S&T project managers were not held accountable for establishing a process to enhance technology transitioning. The inclusion of the requirement in S&T project managers' performance plans to establish and maintain formal coordination with all candidate acquisition programs through establishing IPT groups, creating IPT charters, formalizing and maintaining up-to-date agreements with all candidate acquisition programs of quantitative metrics and key exit criteria, establishing formal transition plans, and developing memorandums of agreement or understanding would significantly assist technology transitioning.

The inclusion of those requirements would hold S&T project managers accountable for establishing a process to enhance transition and serve as a basis for assessing performance as required by Army Pamphlet 70-3. In addition, the performance assessment process would be a management tool at the S&T project manager level (as opposed to only at the division level) to assist in achieving the AMC Strategic Plan and the requirement of the AMC memorandum of September 12, 2001, by providing a link between performance assessments and technology transitioning.

Conclusion

The Department of the Army Pamphlet 70-3, "Army Acquisition Procedures," July 15, 1999, provides discretionary guidance on materiel acquisition management. The Pamphlet is relevant to research, development, and acquisition efforts. The Pamphlet defines technology transition after a validated need is approved and after the technologies critical to performance have been proved. The Pamphlet states that technology transitioning requires early coordination among the S&T project manager, the acquisition program manager, and the user. The Pamphlet provides that, prior to transitioning, the technology must be demonstrated, tested, and shown to be predictable; that there must be a clear military need for the capability; and that the technology introduction must be cost-effective. The Pamphlet states that an S&T project manager will be assigned to each technology project and that the timely accomplishment of the technology should be a basis for assessing the performance of the S&T project manager. Examination of S&T project managers performance plans showed that they do not adequately satisfy the intent of Army Pamphlet 70-3, and performance plans should explicitly require actions related to technology transitioning as a performance element.

Recommendation, Management Comments, and Audit Response

B. We recommend that the Commander, Army Materiel Command require that the personnel performance plans for managers responsible for advanced technology development-funded programs at its Research, Development and Engineering Centers explicitly require an assessment of managers' performance with planned technology users. The performance plans should include performance assessments for the establishment of integrated product teams with all planned technology users, creation of integrated product team charters, coordination and acceptance of quantitative metrics and key exit criteria with all planned users, development of transition plans that are formally agreed to by all planned users, and the development and maintenance of up-to-date memorandums of agreement or understanding with all planned users.

Management Comments. The Commander, Army Materiel Command did not provide comments to the draft report; however, the Assistant Secretary concurred with comment. The Assistant Secretary stated that the Department of the Army concurs with the philosophy of linking personnel performance to program performance. However, only the ATD managers should be held accountable for transition since the predominance of S&T is trying to demonstrate what is possible, and STO technology is too immature for transition. The Assistant Secretary stated that the Commander, Army Materiel Command is reviewing the recommended approach to require an assessment for ATD managers with other performance metrics, such as achieving TRLs.

Audit Response. We considered the Assistant Secretary's comments in preparing the final report. We clarified the recommendation to address the need to include technology transitioning in performance plans for managers who are responsible for advanced technology development programs as opposed to basic and applied technologies.

The Assistant Secretary's comments were partially responsive. We believe that the policy of linking personnel performance to program performance should apply to STO managers as well as ATD managers. We see no distinction between ATD and the STO managers' responsibility in that the programs being managed are supported with advanced technology development funds. Linking technology transitioning to S&T managers' performance would assist in establishing a tone that the DoD is serious about enhancing the likelihood of providing advanced technologies to the warfighter. We request that the Commander, Army Materiel Command provide comments to this recommendation in the final report.

Appendix A. Scope and Methodology

Scope

We examined 20 S&T projects at the Army Tank-automotive and Armament Command, Armament Research, Development and Engineering Center and the Army Aviation and Missile Command, Aviation Applied Technology Directorate to evaluate the management process for transitioning successful technologies to the warfighter. The S&T projects examined at the two Army sites visited were funded with research, development, test, and evaluation appropriations for advanced technology development and had expenditures of $441.5 million and planned additional funding of $244.4 million.

We did not evaluate the technical merits of the S&T projects. We did not review the management control programs at the Army Tank-automotive and Armament Command, Armament Research, Development and Engineering Center or the Army Aviation and Missile Command, Aviation Applied Technology Directorate. We limited our management control review to the management procedures of transitioning technology from S&T projects to the acquisition program managers.

General Accounting Office High-Risk Area. The General Accounting Office has identified several high-risk areas in the DoD. This report provides coverage of the Weapon System Acquisition (DoD WEP SYS ACQ) high-risk area.

Methodology

We conducted interviews with S&T and acquisition program officials, and examined applicable key documentation. Key documentation reviewed included guidance advocated by the Deputy Under Secretary of Defense (Science and Technology); the Army Science and Technology Master Plan for 2001; the Ten-Question Quad Chart; integrated product team charters and meeting minutes; memorandums of understanding or agreement; acquisition program funding profiles; S&T management plans; technology transition paths or plans; the AMC Strategic Plan; the research, development, test, and evaluation budget item justification sheet (R-2 Exhibit); and performance plans for S&T project managers. We reviewed key documentation dated from April 1993 through October 2001. We also conducted interviews with S&T management officials at the Office of the Secretary of Defense and the Army.

We relied on computer-processed data without performing tests of general and application system controls to confirm the reliability of the database. We obtained a computerized listing of Army research, development, test, and evaluation appropriations for advanced technology development from the Office

of the Deputy Assistant Secretary of the Army for Research and Technology. We relied on the computerized listing to represent the known universe of S&T projects in our review of the management process. We validated the total funding on the computerized listing to the total funding of the Army research, development, test, and evaluation appropriations for advanced technology development. The S&T projects reviewed at the two sites visited were active S&T projects and correlated to the data in the computerized listing. Validating the computerized listing to the appropriations was deemed appropriate for this audit because the audit's objective was to examine the management process for transitioning technology, not the individual S&T projects, and further validation of the computerized listing would not change the conclusions in this report.

Audit Dates and Standards. We performed this program results audit from April 2001 through January 2002 in accordance with generally accepted government auditing standards.

Contacts During the Audit. We visited or contacted individuals and organizations within DoD. Further details are available on request.

Management Control Program Review

DoD Directive 5010.38 "Management Control (MC) Program," August 26, 1996, and DoD Instruction 5010.40, "Management Control (MC) Program Procedures," August 28, 1996, require DoD organizations to implement a comprehensive system of management controls that provides reasonable assurance that programs are operating as intended and evaluate the adequacy of the controls.

Scope of the Review of the Management Control Program. We evaluated the management control process to determine whether effective management procedures were established to transition successful S&T projects to acquisition program managers and, ultimately, to the warfighter.

Adequacy of Management Controls. The audit identified that the Army leadership created a comprehensive high-level management oversight process to approve and review proposed and ongoing technologies. However, the Army S&T oversight process does not require the involvement of program executive officers or individual acquisition program managers. The Army S&T oversight process also does not require the establishment of formal coordination documents with acquisition officials as a condition for approval of continued funding. The absence of acquisition officials and formal coordination documents in the oversight process is considered a material management control weakness, as discussed in the Finding section of this report. The recommendations for both findings, if implemented, will improve the transitioning of technology to the acquisition program manager and to the warfighter. A copy of the report will be provided to the senior Army official responsible for management controls.

Prior Coverage

During the last 5 years, the General Accounting Office issued two reports discussing the benefits of adequately managing the challenges of transitioning technologies to warfighters.

General Accounting Office

Report No. GAO-1-311, Defense Acquisition: Army Transformation Faces Weapon Systems Challenges, May 21, 2001

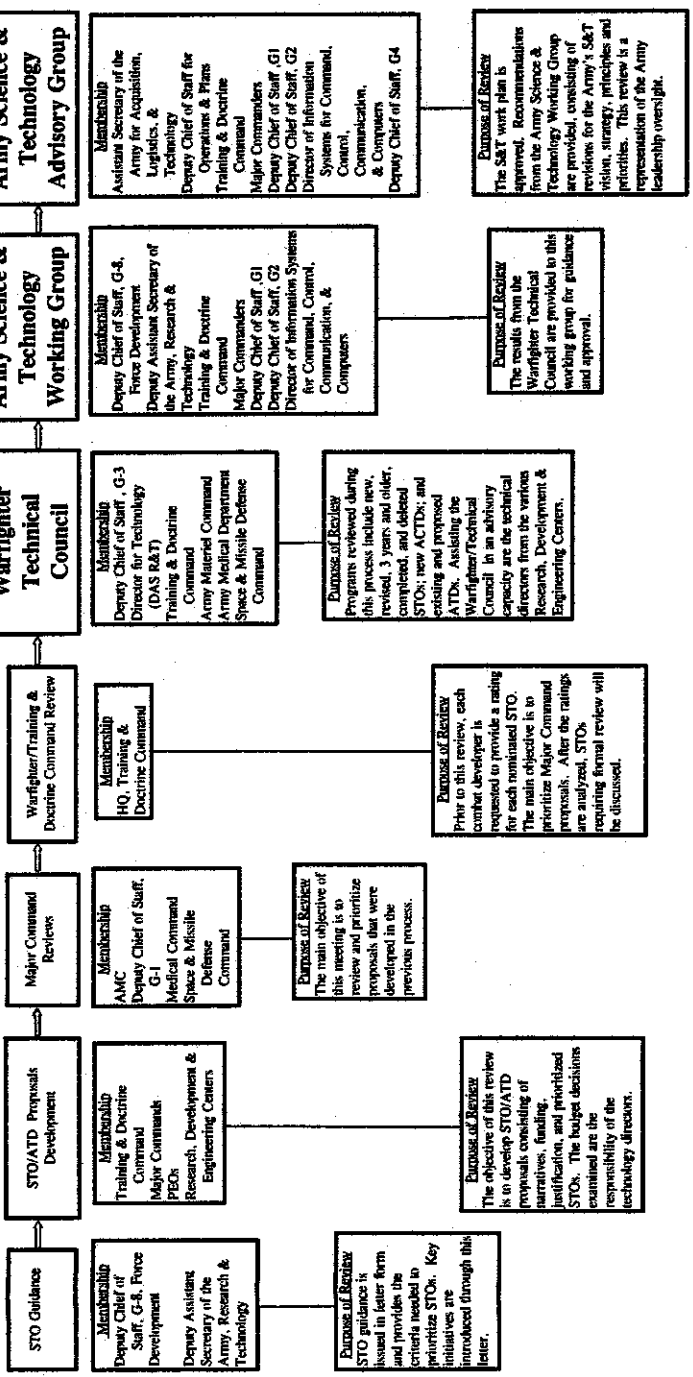
Report No. NSIAD-99-162, Best Practices: Better Management of Technology Development Can Improve System Outcomes, July 30, 1999

Appendix B. Technology Readiness Levels and Their Definitions

The following matrix lists the various technology readiness levels and provides a description of each as listed in Appendix 6 of DoD 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs," 10 June 2001.

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into 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 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 level 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 level 6, requiring the demonstration of an actual system prototype in an operational environment. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this level represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine whether it meets design specifications.
9. Actual system 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. Examples include using the system under operational mission conditions.

Appendix C. Army Science and Technology Approval Process



Appendix D. Summary of Advanced Technology Development Projects Reviewed

Science and Technology Objectives

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Advanced-Light Armament for Combat Vehicles	Future Combat System	-[3]	Yes	No	-[3]	-[3]	-[4]	-[3]	-[3]
	Advanced Amphibious Assault Vehicle	No	Yes	Yes	Yes	No	-[5]	No	No
	PM-Tank and Medium-caliber Armanents System	No	Yes	Yes	Yes	No	-[5]	No	No
Advanced Rotocraft Transmission	PM-Blackhawk	No	Yes	No	No	No	No	No	No
	PM-Comanche	No	Yes	No	No	No	No	No	No
	PM-Apache	No	Yes	No	No	No	No	No	No
	Osprey	No	Yes	No	Yes	Yes	-[5]	No	No
	Rotorcraft Drive Systems for the 21st century	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]
Airborne Manned/ Unmanned System Technology	PM-Apache	No	No	No	No	No	No	No	No

Note: See footnotes at the end of the appendix.

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Area Denial System	Future Combat System	-[3]	Yes	No	-[3]	-[3]	-[4]	-[3]	-[3]
	RAPTOR	No	Yes	No	Yes	No	-[5]	No	No
	PM-Mines, Countermines, and Demolition	No	Yes	No	Yes	No	-[5]	No	No
Electro-Rheological Fluids	Multi-Role Armament and Ammunition System	No	No	No	-[4]	-[4]	-[4]	No	No
Extended Range Munition	PM-Tank and Medium-caliber Armaments System	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Helicopter Active Controls Technology	Variable Geometry Advanced Rotor Demo	-[3]	Yes	Yes[6]	-[3]	-[3]	-[3]	-[3]	-[3]
	PM-Chinook	No	Yes	Yes[6]	No	Yes	No	No	No
	PM-Blackhawk	No	Yes	Yes[6]	No	No	No	No	No
	PM-Longbow Apache	No	Yes	Yes[6]	No	Yes	No	No	No
Joint Turbine Advanced Gas Generator Phase III	Common Engine Program	Yes	Yes	No	Yes	Yes	Yes	No	No

Note: See footnotes at the end of the appendix.

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Light Weight Auto Howitzer TD[7]	PM-Towed Artillery Digitization	No	No	No	No	No	No	-[8]	No
Munition Survivability	Federal Supply System	No	No	No	No	No	No[9]	-[8]	No
	Munitions Survivability Software	No	No	No	No	No	No[10]	-[8]	No
Objective Individual Combat Weapon System Enhancements	PM Small Arms	No	No	No	No	No	Yes	No	No
	Objective Individual Combat Weapon	No	No	No	No	No	Yes	No	No
Rotorcraft Drive Systems for the 21st Century	PM-Blackhawk	No	No	No	No	No	No	No	No
	PM-Comanche	No	No	No	No	No	No	No	No
	Osprey	No	No	No	No	No	No	No	No
	Future Drives (Phase III)	-[3]	-[3]	-[3]	-[3]	-[3]	-[5]	-[3]	-[3]
	PM-Apache	No	-[3]	-[3]	No	No	No	No	No
Responsive Accurate Mission Module	Robotic Follower	No	No	No	No	No	No	No	No
	Forward Deployed Robotic Unit	No	No	No	No	No	No	No	No

Note: See footnotes at the end of the appendix.

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Rotary Wing Structures Technology	PM-Comanche	Yes	Yes	No	Yes	Yes	-[3]	No	No
	PM-Blackhawk	No	Yes	No	No	No	-[3]	No	No
	PM-Apache	No	Yes	No	Yes	Yes	-[3]	No	No

Note: See footnotes at the end of the appendix.

Advanced Technology Demonstrations

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Direct Fire Lethality	Future Combat Systems	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]
	Potential PM-Tank Medium-caliber Armament Systems	No	Yes	Yes	Yes	Yes	No	No	Yes
Multi-Role Armament and Ammunition System	Future Combat Systems	-[3]	Yes[11]	No[12]	-[3]	-[3]	-[4]	-[3]	-[3]
Objective Crew Served Weapon	PM Small Arms	Yes	Yes	Yes	Yes	Yes	No	No	Yes
	Future Combat Systems	-[3]	Yes	Yes	-[3]	-[3]	-[3]	-[3]	-[3]
Objective Individual Combat Weapon[7]	PM Small Arms	Yes	Yes	Yes	Yes	Yes	No	-[3]	No
Precision Guided Mortar Munition	PM Mortar	No	Yes	Yes	Yes	Yes	No	No	No

Note: See footnotes at the end of the appendix.

System	Receiving User	MOA/MOU[1] With User	Established an IPT[2]	IPT[2] Charter	IPT[2] Includes User	IPT[2] Includes Prime Contractor	Funding By Acquisition User to Transition	Receiving User Agreed to Exit Level TRL	Receiving User Agreed to Exit Criteria
Rotorcraft Pilot's Associate	Unmanned Combat Air Vehicle	No	Yes	No	No	No	-[13]	-[8]	No
	RAH-66 (Comanche)	No	Yes	No	No	No	No	-[8]	No
	AH-64D (Longbow Apache)	No	Yes	No	No	Yes	No	-[8]	No
	Army Airborne Command and Control System	No	Yes	No	No	No	-[13]	-[8]	No
	Virtual Cockpit Optimization Program	No	Yes	No	No	No	-[13]	-[8]	No
	Future Scout Cavalry System	No	Yes	No	No	No	-[13]	-[8]	No
	Airborne Manned Unmanned System Technology Demonstration ATD	No	Yes	No	No	No	-[13]	-[8]	No

[1] Memorandum of Agreement; Memorandum of Understanding
[2] Integrated Product Team
[3] Deemed not applicable because the system is transitioning to a receiver who has yet to be clearly defined or the technology is a manufacturing improvement process
[4] Adequate funding has yet to be established because this program is scheduled to transition to the Future Combat System.
[5] No documents were provided to verify this information.
[6] Contract Performance Plan.
[7] System was determined to transition to an acquisition customer.
[8] TRLs were not required prior to FY 2001 STO/ATD cycle.
[9] The fire-blocking blankets and water-filled barricades do not have funding to transition.
[10] STO management team transferred software algorithms that they developed to themselves as part of MSS 1.
[11] IPT establishment is between one STO manager to another STO manager.
[12] Document was outdated and/or not signed by the appropriate officials.
[13] Aviation Applied Technology Directorate officials stated that only pieces of the Rotorcraft Pilot's Associate technology transitioned; therefore, we did not determine whether acquisition programs had funding for the Rotorcraft Pilot's Associate.

Appendix E. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition, Technology, and Logistics
    Deputy Under Secretary of Defense for Science and Technology
Under Secretary of Defense (Comptroller/Chief Financial Officer)
    Deputy Chief Financial Officer
    Deputy Comptroller (Program/Budget)

Department of the Army

Assistant Secretary of the Army for Acquisition, Logistics, and Technology
Assistant Secretary of the Army (Financial Management and Comptroller)
Commander, Training and Doctrine Command
Deputy Chief of Staff for Programs
Commander, Army Materiel Command
    Commander, Tank-automotive and Armaments Command
        Armament Research and Development Engineering Center
    Commander, Aviation and Missile Command
        Director, Aviation Applied Technology Directorate
Project Executive Officer for Aviation
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Non-Defense Federal Organization

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Senate Committee on Appropriations
Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on Defense, Committee on Appropriations
House Committee on Armed Services
House Committee on Government Reform
House Subcommittee on Government Efficiency, Financial Management, and Intergovernmental Relations, Committee on Government Reform
House Subcommittee on National Security, Veterans Affairs, and International Relations, Committee on Government Reform
House Subcommittee on Technology and Procurement Policy, Committee on Government Reform

Department of the Army Comments

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
ACQUISITION LOGISTICS AND TECHNOLOGY
103 ARMY PENTAGON
WASHINGTON DC 20310-0103

REPLY TO ATTENTION OF

23 MAY 2002

SAAL-ZT

MEMORANDUM FOR OFFICE OF THE INSPECTOR GENERAL, DOD

SUBJECT: Audit AB-0105 (Project No. D2001-AB-0105) Transition of Advanced Technology Programs to Military Applications

The Army appreciates the opportunity to provide comments on the Department of Defense Inspector General's (IG's) report on the transition of advanced technology programs to military applications. The Army uses Army Regulation 70-1 (Research, Development and Acquisition, Army Acquisition and Policy) and the Army Pamphlet 70-3 (Research, Development and Acquisition, Army Acquisition Procedures) to establish science and technology program management procedures. These policies and procedures are consistent with OSD policy and guidance.

Recommendations:
A(1). Require the establishment of integrated product teams (IPTs) that include representatives from the candidate acquisition program office(s) and the acquisition prime contractors(s), where appropriate.
Concur. The Army already requires the creation of IPTs that involve both the acquisition and science and technology program managers for all Advanced Technology Demonstration (ATD) programs (16 in FY02). It is neither appropriate nor practical for each Science and Technology Objective (STO) (155 in FY02) to have an IPT. STO programs are of lesser maturity than ATDs and even when successful, require further development before the creation of an IPT and transition to acquisition would be appropriate.

A(2). Require the establishment of formal agreements between the science and technology managers and the candidate acquisition program manager(s) for emerging technologies. The formal agreements should coordinate exit criteria, technology readiness levels, and estimated transitioning timelines.
Concur. ATD management plans, which are approved by the Deputy Assistant Secretary for Research and Technology for all ATDs, document program exit criteria, Technology Readiness Levels (TRLs) and estimated technology transition time frames. The signed ATD management plans serve as Memoranda of Agreement (MOA) or Memoranda of Understanding (MOU) between the science and technology managers and the candidate acquisition program managers.

A(3). Require the establishment of formal memorandums of agreement or understanding and technology transition agreements between the science and

technology manager and candidate acquisition program manager(s). The establishment of the formal agreements should be a requirement for continued research, development, test and evaluation funding.
Concur. . The Army's ATD management plans serve as formal MOAs/MOUs and as Technology Transition Agreements.

A(4). Require the participation of the program executive officer and the acquisition program manager in the Army science and technology annual review process. The program executive officer and acquisition program manager should review and formally comment on the feasibility of science and technology projects that are integrating and transitioning into acquisition programs.
Concur. Action is underway this year to include PEOs in the Army Science and Technology Working Group (ASTWG), the 2-star body that approves all STOs and ATDs.

A(5). Review the technology paths or plans for the 18 science and technology projects identified in this audit and discontinue any projects that does not have formal acquisition program support.
Nonconcur. S&T by its nature examines the feasibility of technology to solve warfighter problems and as such not all efforts will be successful to have established transition paths to acquisition. Only the most technically mature efforts in the advanced technology development program – the Advanced Technology Demonstrations – should be considered and planned for transition to acquisition. There are numerous GAO reports that correctly criticize the Services for attempting transitions when technology is immature.

One needs to understand that the nature and role of science and technology in relation to acquisition. Science and technology examines potential technologies to fulfill warfighter needs, which may or may not have successful paths to acquisition but these investments produce gains through increased technology understanding. For FY03 approximately 15% of the budget requested program is for Basic Research. The nature of this work is discovery and understanding - trying to expand our knowledge base. Basic research does not directly transition to acquisition. Knowledge gained here can result in understanding of science to develop practical application approaches. As these approaches become feasible they are worked in the Applied Research Program, which encompasses another 40% of the annual science and technology budget. When laboratory applications of applied research can be repeated and show military utility to our warfighting customers, it can be further evaluated in the most mature technology environment, the Advanced Technology Development Program. Advanced technology development funding provides the remaining 45% of the annual science and technology budget. It is this investment in advanced technology development that has the highest probability of providing transitionable "products." Within these efforts there are three broad categories of activity: 1) advanced technology demonstrations, 2) science and technology objectives and 3) other advanced technology efforts. The ATDs are the most complex and mature S&T efforts with the closest linkage to acquisition

programs. The Army requires that ATD managers obtain a transition endorsement from the appropriate Title 10 Program Manager and the Army coordinates programming for needed transition funding within resource constraints. ATD managers are already held accountable to achieve their program's exit criteria, which include transition to acquisition. The STOs are typically less complex S&T efforts, and their ability to transition into acquisition is based upon Army funding priorities and warfighting requirements that would require fielding of these technologies. Whether transitioned into PM programs or not, these efforts remain valuable as "proofs" of technology and operational concepts that can provide advanced warfighting capabilities. The remaining advanced technology efforts are used to pursue higher risk technology. These technologies have a lower probability of success than ATD or STO efforts and therefore should not be programmed for transition to PMs. However, successful work in this area can lead to future ATD or STO programs that can provide an advance in technology to the PM.

B(1). We recommend that the Commander, Army Materiel Command, require that the personnel performance plans of science and technology project managers at its Research, Development and Engineering Centers explicitly require an assessment of managers' performance with planned technology users. The performance plans should include performance coordination assessments for the establishment of integrated product teams with all planned technology users, creation of integrated product team charters, coordination and acceptance of quantitative metrics and key exit criteria with all planned users, development of a formal transition plans that are formally agreed to by all planned users, and the development and maintenance of up-to-date memorandums of agreements or understanding with all planned users. **Concur with Comment.** Headquarters DA concurs with the philosophy of linking personnel performance to program performance. However, only the ATD Program Managers should be accountable for transition since the predominance of S&T is trying to demonstrate the art of the possible and is too immature for transition into acquisition. The Commander of the Army Materiel Command is reviewing the recommended approach to require an assessment of ATD program managers' performance with planned technology users. Other performance metrics, such as progress in achieving scheduled technology readiness levels as specified in the GAO Report entitled, "Better Management of Technology Development Can Improve Weapon Systems Outcomes," are being used to evaluate S&T personnel.

General Comments:

The role of the Science and Technology (S&T) community within the Army is to provide both a near term capability and a far-term focus for the future. It is the responsibility of the S&T community to "bring technology options to the table". Once the technology has shown an appropriate level of maturity, such as a proof-of-concept demonstration, S&T Program Managers (PMs) negotiate with acquisition Program Managers to identify appropriate transition points. When the acquisition Program Manager determines that a technology is needed to satisfy required capability and can meet the acquisition program schedule, then the acquisition

Program Manager will seek System Development and Demonstration transition funding (6.4).

The report does not mention or address the primary role of all of S&T efforts. This role is to deliver options to the warfighter so that they can choose the best approach available at the time that it is needed. It is critical that the S&T community be allowed to do exploration prior to discovery... to look at problems with an open solution set, vice a pre-determined path. The ability to keep the options open for as long as possible is a main reason for not requiring a 6.4 funding tail for all of the S&T efforts. The acquisition community does not have the resources to pursue all of the proposed options and a requirement for a funding tail for all S&T efforts would force a down-selection of technology too early in the development cycle. The Army has implemented recommendations from the GAO Report, "Better Management of Technology Development Can Improve Weapon Systems Outcomes," GAO/NSIAD-99-162, dated July 1999. In this report, the GAO recognized that a key factor to the successful management of technology was to make the S&T organization, rather than the program or product development manager, responsible to maturing technology to a high Technology Readiness Level (TRL), hence our adoption of TRLs as a key indicator of maturity. The GAO report also provides a good description of the role of S&T in general. The report indicates, "DOD's science and technology community is responsible for basic research, applied research, and advanced technology development to produce generic, rather than weapons-specific, technologies. Its goal is to conduct research, develop technology, and farm these efforts for potential military application; such as a weapons system...the S&T officials stated role is to show that technology is feasible through laboratory experiments and demonstration." It is understood that not all S&T programs will transition into an Army system. However, transition is not the sole purpose of the Service S&T programs. The purpose of STOs and ATDs are to focus on work needed by the warfighter. The S&T community will ultimately transition the technology when the Army decides that it needs the capability and has funds for its acquisition.

Actions Reported Subsequent to the IG Review:

Advanced Rotorcraft Transmission (ART): The Split Torque design developed under ART I has transitioned into the Comanche. ART II technologies are being transitioned into the RDS21 Tech Demo.

Airborne Manned/Unmanned Systems Technology (AMUST): AMUST Technology along with Rotorcraft Pilot's Associate are the two key technologies that will be demonstrated in the Hunter Stand-off Killer Team (HSKT) ACTD. The AMUST Baseline capability has been demonstrated on the AH-64 and is planned for integration into Lot #7 Apache Longbow (FY04-FY10). In addition, this technology will meet the Comanche timeline to transition to RAH-66 Block I upgrades (UAV Level 4 Control). The Comanche PM has endorsed this technology in the RAH-66 Technology Transition Agreement. Furthermore the AMUST technology has been identified by the PM for a Product improvement for the Army Airborne Command and Control System (A2C2S) Blackhawk.

Rotorcraft Pilot's Associate (RPA): RPA Technology has transitioned into the AMUST STO and the HSKT ACTD that will transition to the fleet as noted above. In addition, the RPA Technology has transitioned to the DARPA/Air Force Unmanned Combat Air Vehicle (UCAV) and the Army Airborne Command and Control System (A2C2S) Blackhawk.

Helicopter Active Controls Technology (HACT): PM Comanche has endorsed HACT and the timeline for transition to RAH-66 Block I upgrades in the RAH-66 Technology Transition Agreement.

Rotary Wing Structures Technology (RWST): The technology has transitioned directly into the Comanche. The Comanche PM is currently using the RWST demonstration component design as the baseline structural design for the lower forward fuselage of the Comanche. Furthermore the design methodologies and processes that are developed as a part of RWST will continue to be used by the prime manufacturer in all future product designs. The contractor is in the process of institutionalizing the design process and methodologies throughout the company, which will benefit both their military and commercial customers.

Rotor Drive System for the 21st Century (RDS-21): PM Comanche has endorsed RDS-21 in the RAH-66 Technology Transition Agreement. In addition, the technology will feed the development of the DARPA/ARMY Unmanned Combat Armed Rotorcraft (UCAR).

Precision Guided Mortar Munition (PGMM): PM Mortars has received FY02 Congressional funding for the Component Advanced Development program as part of PGMM and there is funding for SDD in the POM starting in FY04. PM Mortars has agreed to the ATD exit level TRLs.

Objective Individual Combat Weapon (OICW) System: PM Objective Individual Combat Weapon has endorsed the OICW Systems Enhancement STO and has concurred that the TRLs and the metrics as stated in the STO charts are the agreed upon program exit criteria.

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