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Report to Congressional Committees

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SCIENCE AND TECHNOLOGY

Air Force's Planning Process Meets Statutory Requirement

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United States General Accounting Office
Washington, D.C. 20548

February 14, 2002

The Honorable Carl Levin
Chairman
The Honorable John W. Warner
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Bob Stump
Chairman
The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services
House of Representatives

The successful outcome of military operations often depends on weapons systems that emerged from research conducted decades earlier. For example, the Air Force's investment in low observable stealth technology in the 1970s led to the F-117 fighter, which was very effective in Operation Desert Storm. Since the end of the Cold War, however, the focus of science and technology has narrowed as a consequence of steady funding declines. The Air Force has been criticized for focusing its research more on existing or emerging weapons and less on long-term technology development. There is a growing concern in the scientific community that the Air Force's investment in science and technology may be too low to meet the challenges presented by new and emerging threats.

The Congress has also been concerned about the Air Force's declining investment in science and technology. The National Defense Authorization Act for Fiscal Year 2001[1] requires that the secretary of the Air Force review the long-term challenges and short-term objectives of the Air Force's science and technology programs. The act further requires that the review assess the budgetary resources currently used and those needed to adequately address the challenges and objectives. The act also requires that we assess the extent to which the Air Force has complied with the provisions of the act and report to the Congress on the results of our review. In discussions with your offices, we agreed to focus our review on whether the Air Force complied with the criteria specified in the act and

[1] Public Law 106-398, Oct. 30, 2000.

the process-related requirements of the act and not on the technical merits of the research projects identified. This report addresses the three primary areas specified in the act:

- long-term challenge identification and planning,
- short-term objective identification and planning,
- program and budgetary resource assessment.

Results in Brief

The Air Force complied with the requirements of section 252 of the Fiscal Year 2001 National Defense Authorization Act. As required, the Air Force established an integrated product team to identify long-term science and technology challenges and a task force to identify short-term objectives. For each challenge or objective that was identified, the Air Force complied with the provision to establish teams to identify potential technological capabilities needed to achieve these goals. Each team selected research projects that addressed the criteria specified in the act. For example, each short-term objective represented a compelling Air Force requirement, as the act specified. The Air Force also complied with the act's process provisions. For example, the long-term challenge teams met the requirement to conduct workshops to identify promising areas of research. Upon completion of the planning process, the secretary of the Air Force delegated to the deputy assistant secretary of the Air Force for Science, Technology and Engineering, the requirement to review the results of the teams' work and identify any science and technology research not currently funded. The deputy complied with the act's review provisions. The Department of Defense has reviewed this report and concurs with its contents.

Background

Science and technology is traditionally divided into three broad categories: basic research, applied research, and advanced technology development. *Basic research* attempts to produce new knowledge in a scientific or technological area. This research is not associated with a specific weapon system. *Applied research* supports the development and maturation of new technologies for a defined military application. *Advanced development* entails large-scale hardware development and technology integration in more operationally realistic settings. Research and

development beyond these categories is done in support of a specific weapon system.

In the Air Force, the focal point for science and technology investments is the Air Force Research Laboratory. It was created in 1997 to centrally manage all Air Force science and technology efforts. Previously, the Air Force operated 13 different laboratories across the country. The present Air Force Research Laboratory, headquartered at Wright Patterson Air Force Base, comprises 10 technology directorates. Nine directorates handle applied and advanced development projects. The 10th directorate, the Office of Scientific Research, manages the Air Force's basic research projects. The Air Force Research Laboratory biennially generates a comprehensive strategic plan that supports the national military strategy and the Air Force Strategic Plan.

In the past, the Air Force was a leader in high-technology exploration. According to a January 2000 Air Force Association study, the Air Force was the unquestioned leader in science and technology investments at the end of the Cold War.[2] In the 1990s, however, it dropped to third place, behind the Army and Navy. The Congress has been concerned about the Air Force's level of investment in science and technology. For fiscal year 2000, the House and Senate Armed Services Committees noted that the Air Force in particular, had failed to comply with the science and technology funding objective specified in the prior year's authorization act, thus jeopardizing the stability of the technology base and increasing the risk of failure to maintain technological superiority in future weapons systems. In 2001, the Scientific Advisory Board found that the Air Force's science and technology program needed to improve its planning process and generate stronger user support and sponsorship.[3] It also found weaknesses in the connection between operational requirements and science and technology programs, which inhibited the prioritization of investments.

Long-Term Planning Complies with Act

The Air Force complied with the overall requirements of the National Defense Authorization Act regarding long-term challenges. (See table 1 for the checklist of provisions.)

[2]See *AFA Special Report: Shortchanging the Future*, Air Force Association (Jan. 2000).

[3] See *Report on Science & Technology and the Air Force Vision: Achieving a More Effective S&T Program*, Scientific Advisory Board (May 2001).

Table 1: Long-Term Challenge Checklist

Section	Actions required by statute	Yes	No
252(c)(1)	Did the secretary of the Air Force establish an integrated product team to identify high-risk, high-payoff long-term challenges?	●	
	Did the integrated product team include Office of Scientific Research and Air Force Research Laboratory representatives?	●	
252(c)(2)	Did the integrated product team solicit views from the entire Air Force science and technology community on matters considered by team?	●	
252(c)(3)(A)	Did the integrated product team select candidate projects that involve compelling Air Force requirements; high-risk, high-payoff areas of exploration; and very difficult but achievable results?	●	
252(c)(3)(B)	Did the integrated product team avoid selecting projects that are a linear extension of ongoing science and technology projects?	●	
252(c)(4)	For each long-term challenge, did the Deputy Assistant Secretary for Science, Technology, and Engineering designate a ● technical coordinator? ● management coordinator	●	
	Does the technical coordinator have sufficient expertise to identify other experts and affirm the credibility of the long-term challenges?	●	
	Did the long-term challenge coordinators conduct workshops in the science and technology community?	●	
	From these workshops, did they obtain suggestions on ● possible approaches to address the long-term challenges? ● current work that address the long-term challenges? ● deficiencies in current work regarding long-term challenges? ● promising areas of research?	●	

The act defined a long-term challenge as a high-risk, high-payoff effort that will provide a focus for research in the next 20 to 50 years. To identify potential long-term challenges, an Air Force review team obtained over 140 ideas from a variety of sources in the scientific community. Ideas ranged from cloaking technologies (the deceptive masking of assets) and holodeck command capabilities (virtual reality battlespace control) to micro weapons like ubiquitous “battle bees” (miniaturized unmanned air vehicles) and cyber warfare technologies.

The team evaluated these ideas to ensure that they complied with the three primary criteria specified in the act. The potential long-term challenges had to involve (1) compelling Air Force requirements; (2) high-risk, high-payoff areas of exploration; and (3) very difficult but achievable results. Yet another provision in the act required that the team should avoid selecting projects that are linear extensions of ongoing science and technology projects. This provision was more difficult to assess, but after

additional deliberations, the team determined that the following six challenges satisfied the criteria in the act:

- *Finding and Tracking.* To provide the decision maker with target quality information from anywhere in near real-time.

- *Command and Control.* To assess, plan, and direct aerospace operations from anywhere or from multiple locations in near real-time.

- *Controlled Effects.* To create precise effects rapidly, with the ability to retarget quickly against complex target sets anywhere, anytime, for as long as required.

- *Sanctuary.* To protect our total force from natural and man-made hazards or threats, allowing us to operate anywhere with the lowest risk possible.

- *Rapid Aerospace Response.* To respond as quickly as necessary to support peacetime operations or crises and move this response to another location very rapidly if needed.

- *Effective Aerospace Persistence.* To sustain the flow of equipment and supplies as well as the application of force for as long as required.

Once the long-term challenges were identified, the Air Force followed the planning process specified in the act. For example, it established six work groups tasked with identifying possible approaches to address these challenges. The groups had about 9 weeks to complete their work. As required, a technical coordinator, assisted by a management coordinator, headed each group. Each group also complied with the requirement to hold a workshop within the science and technology community to obtain suggestions on possible approaches and promising areas of research. The workshop participants satisfied the requirement to identify current work that addresses the challenge, deficiencies in current work, and promising areas of research.

Finally, the groups were also expected to select projects that were not linear extensions of current science and technology work. This particular provision was not easy for some groups to define. Some pondered the relative nature of the term. For example, a user would perceive "nonlinearity" differently than a scientist. Another group characterized it as a quantum leap in capability. Another definition associated nonlinear

projects with multiple-capability dimensions. For example, if doubling the payload capacity of a weapon is a linear extension, then doubling the payload, speed, and range of the weapon would also be a nonlinear extension. Regardless of the definition selected, each group addressed the issue in its planning process.

Each group summarized the results of its workshop in a briefing that contained enabling capabilities, research areas, technology roadmaps, and associated funding requirements. In many cases, the level of funding projections was double or triple the level of the planned budget. For example, the level of funding projections for basic research in physics, materials, mathematics, and computer science was more than triple the planned investment levels.

Short-Term Planning Satisfies Requirements

The Air Force complied with the overall provisions of the National Defense Authorization Act regarding short-term objectives. (See table 2 for the checklist of provisions.) As required, the Air Force established a task force consisting of representatives from the Air Force Chief of Staff and combatant commands to identify short-term objectives. The task force obtained about 58 ideas from the requirements, user, and acquisition communities as specified in the act. Because of the mandated short-term focus, most of the input involved enhancing or accelerating ongoing research efforts—not initiating entirely new areas of research. These ideas included maintaining aging aircraft, combat identification, and time-critical targeting. While these are not new concepts, they still present significant technological challenges. We have recently reported on weaknesses in each of these areas.[4]

[4]See U. S. General Accounting Office, *Tactical Aircraft: Modernization Plans Will Not Reduce Average Age of Aircraft*, GAO-01-163 (Washington, D. C.: 2001); *Combat Identification Systems: Strengthened Management Efforts Needed to Ensure Required Capabilities*, GAO-01-632 (Washington, D. C.: 2001); and *Joint Warfighting: Attacking Time-Critical Targets*, GAO-02-204R (Washington, D.C.: 2001).

Table 2: Short-Term Challenge Checklist

Section	Actions required by statute	Yes	No
252(d)(1)	Did the secretary of the Air Force establish a task force to identify short-term technological objectives of the Air Force's science and technology programs?	●	
	Is the task force chaired by the deputy assistant secretary for Science, Technology and Engineering?	●	
	Did the task force include representatives from ● the Air Force Chief of Staff ● specified combatant commands of the Air Force?	●	
252(d)(2)	Did the task force solicit views from the entire Air Force ● requirements community? ● user community? ● acquisition community?	●	
252(d)(3)	Did the task force select for consideration short-term objectives that ● involve compelling requirements of the Air Force? ● involve support in the user community? ● will likely attain desired benefits within 5 years?	●	
252(d)(4)	Did the deputy assistant secretary for Science, Technology and Engineering establish an integrated product team for each short-term objective?	●	
	Did the integrated product team include representatives from the ● requirements community? ● user community? ● science and technology community with relevant expertise?	●	
252(d)(5)(A)	Was the integrated product team responsible for identifying the enabling capabilities necessary for achieving the objective?	●	
	Was the integrated product team responsible for defining the enabling capabilities necessary for achieving the objective?	●	
	Was the integrated product team responsible for prioritizing the enabling capabilities necessary for achieving the objective?	●	
252(c)(5)(B)	Was the integrated product team responsible for identifying deficiencies in the enabling capabilities that must be addressed if the short-term objective is to be achieved?	●	
252(c)(5)(C)	Was the integrated product team responsible for working with the Air Force's science and technology community to identify science and technology projects and programs that should be undertaken to eliminate each deficiency in an enabling capability?	●	

The task force reviewed each idea to ensure that it complied with the criteria in the act: (1) to involve compelling Air Force requirements, (2) to have support within the user community, and (3) to likely attain the desired benefits within 5 years. To ensure that each idea represented a compelling Air Force requirement, the task force evaluated each idea against the Air Force's core competencies and critical future capabilities. To meet the user support requirement, the task force linked each potential short-term objective to specific mission needs and requirements documents. The objectives were reviewed and approved by the Air Force's corporate

structure. To ensure that the projects selected would achieve results in 5 years, the task force decided to use the technology maturity levels highlighted in a recent GAO report.[5] The following is a list of the eight short-term objectives.

- *Target Location, Identification, and Track.* To detect, locate, track, and identify air/ground targets anytime in countermeasure environments in near real time.

- *Command, Control, Communication, Computers, and Intelligence.* To dynamically assess, plan, and execute global missions.

- *Precision Attack.* To engage air and ground targets from manned and unmanned vehicles with the precision and speed necessary to bring about decisive results.

- *Space Control.* To increase the survivability of critical space assets.

- *Access to Space.* To improve access to space through responsive, cost-effective launch systems.

- *Aircraft Survivability and Countermeasures.* To improve the ability to survive and operate against airborne and ground threats in all environments.

- *Sustaining Aging Systems.* To extend the service life of aging aircraft and space launch systems with reduced manpower, reduced total ownership costs, and enhanced reliability.

- *Air Expeditionary Forces Support.* To provide air expeditionary forces with the ability to operate with highly responsive and agile combat support forces.

After the objectives were identified, the Air Force complied with the planning process specified in the act. As required, it established an integrated product team to address each short-term objective. Each team was composed of a cross-cutting mix of officials from the requirements,

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

user, and science and technology communities, as the act specified. According to many of the short-term objective team leaders, the cross-cutting nature of the teams was very productive. Not only did they believe that their planning was enhanced by the direct input from users and requirements officials, they also believed that the expertise and assistance from scientists in other laboratory directorates improved the process.

Each team satisfied the requirement to identify, define, and prioritize the enabling capabilities necessary to meet the objectives. As required, each team identified the deficiencies in the enabling capabilities and projects necessary to eliminate the deficiencies. The teams summarized their work in briefings that contained prioritized lists of enabling capabilities, a definition of the objectives, technology roadmaps, and budget spreadsheets. The spreadsheets detailed the current and additional funding required to achieve the objectives. Obtaining the additional funding was a concern to many teams. Many teams identified funding requirements that greatly exceeded current funding levels; it was not uncommon for proposed annual funding levels to double or triple the level currently projected. For example, the Command, Control, Communication, Computer, and Intelligence team proposed programs that would require from 2.6 to over 4 times the planned annual investment.

Another concern was the 15-year gap between the short-term objective and long-term challenge planning. According to the act's provisions, the short-term teams were required to focus on technologies that would be mature in 5 years; the long-term teams focused on technologies needed 20 to 50 years in the future. According to laboratory officials, this mid-term gap constitutes much of the normal science and technology planning effort and represents a critical point in science and technology project development. This time frame is where science and technology can have a significant impact. The Air Force currently addresses this time frame in its normal planning process. In addition, this period is covered in the long-term challenge technology roadmaps, at least for the research efforts associated with those six challenges.

Program and Resource Assessment Complies with Act

The Air Force satisfied the top-level review requirements in the act. (See table 3 for the checklist of provisions.) The act required the secretary of the Air Force to conduct a timely review of the science and technology programs and to assess the budgetary resources needed to address the long- and short-term needs. The secretary delegated this responsibility to the deputy assistant secretary for Science, Technology and Engineering.

The deputy complied with the requirement to conduct a review of the long- and short-term science and technology programs within the 1 year time limit specified in the act. On October 25, 2001, the deputy briefed the secretary on the final results and received his approval.

Table 3: Resource Assessment Checklist

Section	Actions required by statute	Yes	No
252(a)	Did the secretary of the Air Force conduct a review of the Air Force's long-term and short-term science and techology programs no later than 1 year after the enactment of P.L.106-398?	●	
252(b)(1)	Did the secretary assess fiscal year 2001 budget resources used to address long and short-term science and technology needs?	●	
252(b)(2)	Did the secretary review the budget resources needed to adequately address those needs?	●	
252(b)(3)	Did the secretary develop a course of action for each projected or ongoing science and technology program that does not address long- and short-term objectives?[a]		
252(c)(5)	Did the secretary review the long-term challenges identified?	●	
252(c)(5)(A)	Did the secretary consider the results of the long-term challenge workshops conducted?	●	
252(c)(5)(B)	Did the secretary identify any work not currently funded that should be performed to meet long-term challenges?	●	
252(c)(6)	Did the secretary review each short-term science and technology objective?	●	
252(c)(6)(A)	For each short-term objective, did the secretary consider the work of the integrated product teams in paragraph (5)?	●	
252(c)(6)(B)	For each short-term objective, did the secretary identify the science and technology work that should be undertaken to eliminate each deficiency in enabling capabilities that the integrated product team identified in subparagraph (5)(B)?	●	

[a] Not applicable: No course of action was needed because the secretary found that these programs did address the long- or short-term objectives.

The act also required the secretary to assess the fiscal year 2001 budget resources used and needed to adequately address science and technology needs. After consultation with representatives from the House and Senate Armed Services Committees, however, the deputy changed the budget baseline to fiscal year 2002. This was done to reflect the science and technology budget realignment occurring in fiscal year 2002. The deputy assessed the 2002 budget resources planned for science and technology programs and determined that they were adequately funded. The deputy noted, however, that the current level of funding would enable the programs to pursue the minimum level of scientific research. Additional funding would be required to pursue other projects. The deputy also

complied with the provision to evaluate whether the ongoing and projected science and technology programs addressed the long- and short-term science and technology needs. He determined that the programs did address these needs, thus obviating the requirement to develop a course of action for science and technology programs that do not address the long-term challenges or short-term objectives.

Finally, the act required the secretary to review the long-term challenges and short-term objectives and to identify additional work that should be undertaken to meet the challenges and objectives. The deputy complied with both provisions. Not only did he review the results of the long- and short-term planning efforts and identify additional work, but he also directed that the additional work be incorporated into the laboratory's future planning, programming, and budget decisions. The deputy was in a unique position to address these requirements. He served not only as the overall review director for the science and technology planning process, but also as the chairman of the short-term objective task force. As a result, the deputy had many opportunities to review the work of both the long-term challenge and particularly the short-term objective planning teams.

Recommendations

Because the Air Force complied with the provisions of the act, we are not making any recommendations in this report.

Agency Comments

The Department of Defense has reviewed this report and concurs with its contents.

We conducted our work from May 2001 to January 2002 in compliance with generally accepted auditing standards. Additional information on our scope

and methodology is located in appendix I. If you have any questions about the information contained in this letter, please call me at (202) 512-4530. Major contributors to this work included Robert Murphy, Rae Ann Sapp, and Kristin Pamperin.

Sincerely yours,

James F. Wiggins
Director
Acquisition and Sourcing Management

Scope and Methodology

To document the extent to which the Air Force complied with the long-term planning process specified in the National Defense Authorization Act for Fiscal Year 2001, we obtained appointment letters, membership rosters, initial guidance and work plans, meeting schedules, biographies of each technical coordinator, and a comprehensive listing of the initial long-term challenge ideas. We also obtained minutes from team meetings, weekly activity reports, E-mail communications, interim and final briefing reports, associated studies, workshop agendas and results, current and projected budget spreadsheets, capability lists, and promising research areas. To discuss how each team addressed the act's provisions, we met with each long-term challenge technical coordinator and management coordinator. We also met with officials from the Air Force Research Laboratory's headquarters and the Office of the Deputy Assistant Secretary for Science, Technology, and Engineering. Finally, we physically observed the proceedings of one long-term challenge workshop over the course of 2 days. To determine whether each provision was addressed, we prepared summary checklists for each long-term challenge and keyed the data back to a specific provision of the act.

To document the extent to which the Air Force complied with the short-term objective planning process specified in the act, we obtained appointment letters, membership rosters, initial guidance and work plans, meeting schedules, and a comprehensive listing of the initial short-term objective ideas. We also obtained weekly activity reports, short-term objective descriptive summaries, meeting minutes, E-mail communications, interim and final briefing reports, current and projected budget spreadsheets, and prioritized listings of enabling capabilities. To discuss how each team addressed the act's provisions, we met with each short-term objective director. We also met with officials from the Air Force Research Laboratory's headquarters and the Office of the Deputy Assistant Secretary for Science, Technology, and Engineering. Finally, we physically observed the proceedings of one short-term objective workshop. To evaluate whether each provision was addressed, we prepared summary checklists for each short-term objective and keyed the data back to a specific provision of the act.

To document the extent to which the Air Force complied with the program and budgetary resource assessment process specified in the act, we obtained the final weekly activity reports, internal correspondence, review schedule, and overview briefing. To evaluate whether each provision was addressed, we prepared a summary checklist and obtained a written summary of the Air Force's actions to comply with the provisions. Finally,

we discussed the Air Force's actions with representatives from the Office of the Deputy Assistant Secretary for Science, Technology, and Engineering.

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