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Report to the Ranking Democratic Member, Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

September 2006

U.S. AEROSPACE INDUSTRY

Progress in Implementing Aerospace Commission Recommendations, and Remaining Challenges

GAO-06-920

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Highlights

Highlights of GAO-06-920, a report to the Ranking Democratic Member, Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

Why GAO Did This Study

The U.S. aerospace industry's wide-ranging activities—including commercial aviation, national security, and space exploration—make it critical to the economic health and strategic strength of our nation. However, the industry faces challenges, such as a national air traffic management system that, in its present form, cannot handle expected increases in demand; an aging aerospace workforce; and an increasingly competitive global market. In response to these and other challenges, Congress established the Commission on the Future of the United States Aerospace Industry in 2001 to recommend potential actions by the federal government and others to support a robust aerospace industry in the 21st century. In 2002, the Commission made recommendations to address these challenges.

This report discusses (1) the extent to which federal agencies have addressed selected Commission recommendations and (2) the challenges that remain in addressing the recommendations. Based on the opinions of former Commissioners and GAO research, GAO selected recommendations dealing with the national airspace system, space policy, government-wide management structure, international issues, the aerospace workforce, and research and development. This report is based on reviews of agency documents, literature, and interviews with aerospace experts and officials from relevant federal agencies.

www.gao.gov/cgi-bin/getrpt?GAO-06-920.

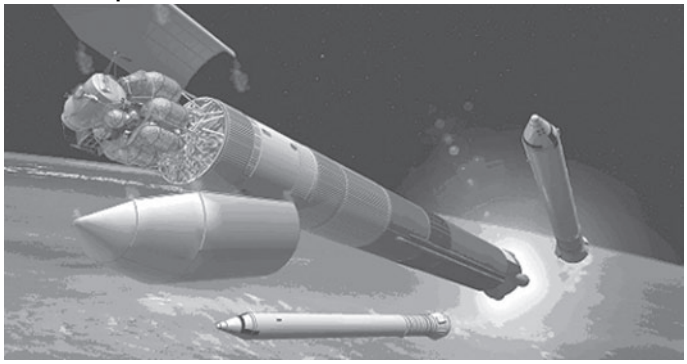
To view the full product, including the scope and methodology, click on the link above. For more information, contact Gerald L. Dillingham at (202) 512-2834 or dillinghamg@gao.gov.

What GAO Found

Federal agencies have taken actions that address selected Commission recommendations to varying degrees, from establishing new offices, programs, and policies to changing existing programs or policies; however, the actions the agencies have taken are still in the early stages of implementation. For instance, the creation of the Joint Planning and Development Office (JPDO) addresses the recommendation to establish an interagency office to plan a new, highly automated air traffic management system; however, JPDO faces challenges in leveraging resources and maintaining the commitment of nonfederal stakeholders. Additionally, the National Aeronautics and Space Administration (NASA) created a directorate to implement the President's new space exploration policy, which addresses the Commission's space exploration recommendation. Aerospace experts told us that they believe this may negatively affect other space exploration programs that have significant benefits. Changes to existing programs include NASA's restructuring of its aeronautics research program and FAA's attempts to increase the U.S. presence in international aviation partnerships. Federal agencies have taken few, if any, actions to address other Commission's recommendations, such as creating a government-wide management structure for aerospace.

Challenges remain for federal agencies in further addressing the Commission's recommendations, including dealing with difficult budgetary trade-offs and collaborating on actions involving multiple agencies. For example, federal agencies may have to give priority to some programs that address Commission recommendations at the expense of other programs because of budget limitations. In addition, with multiple agencies involved in the U.S. aerospace industry, a lack of coordination among them, aerospace companies, and universities could result in duplication and inefficient resource leveraging. GAO provided a draft of this report to the relevant federal agencies. The Department of Defense had no comments; the other agencies generally concurred with the report, but provided clarifications and technical comments, which GAO incorporated as appropriate.

Proposed Cargo Launch Vehicle with Lunar Lander Is an Example of Aerospace Research and Development



Sources: NASA; John Frassanitio and Associates.

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Abbreviations

ADS-B	Automatic Dependent Surveillance Broadcast
ASTS	Aeronautics, Science, and Technology Subcommittee
ATO	Air Traffic Organization
DOT	Department of Transportation
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IPT	integrated product team
JPDO	Joint Planning and Development Office
NASA	National Aeronautics and Space Administration
NGATS	next generation air transportation system
OSTP	Office Science and Technology Policy
R&D	research and development
RNP	required navigation performance
SESAR	Single European Air Traffic Management Research Programme
SMART	Science and Mathematics Access to Retain Talent
STEM	science, technology, engineering and mathematics

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Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

September 13, 2006

The Honorable Jerry F. Costello
Ranking Democratic Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

Dear Mr. Costello:

The U.S. aerospace industry is critical to the economic health and strategic strength of the nation. The industry's wide-ranging activities—including aircraft manufacturing and commercial aviation—make it a major contributor to U.S. economic growth. The Aerospace Industries Association estimates that the industry employs approximately 625,000 people with sales of approximately $170 billion in 2005. This economic benefit is in part due to the United States' global leadership in the development of a robust commercial aviation industry, the industry's employment of a highly skilled and trained workforce, and the manufacture of civil and defense aerospace products. These factors have allowed the U.S. aerospace industry to produce significant improvements in science, technology, and national security in and beyond the aerospace field. For example, the global positioning system uses satellites, ground control networks, and user equipment to provide navigational information for land, sea, and airborne navigation; surveying and mapping; farming; telecommunications; and a wide variety of other applications.

However, the aerospace industry faces a host of challenges, such as a national air traffic management system that, in its present form, lacks the capacity to handle expected increases in air traffic; an aging aerospace industry workforce; and an increasingly competitive global market that may threaten the U.S. industry's traditional leadership in aerospace manufacturing. According to the Federal Aviation Administration (FAA), the demand for both passenger and cargo air service will continue to grow for the foreseeable future, and these increases will place a greater strain on the current national airspace system—increasing airspace congestion and delays, and resulting in negative economic effects. Additionally, the government has reported that an estimated 26 percent of aerospace workers will be eligible to retire by 2008, and there are concerns about the availability of sufficiently trained workers to fill these positions. Furthermore, the industry has reported having difficulty not only retaining

its existing workforce, but also attracting young people into the field. Finally, increased global competition from both foreign companies and governments will place even more pressure on the industry. For example, the European Union published two reports—STAR-21[1] and Vision 2020[2]—that establish European aerospace policy objectives, including the use of government resources to pursue global leadership by European aerospace companies.

In response to these and other challenges, Congress established the Commission on the Future of the United States Aerospace Industry (the Commission) in 2001 to study the issues associated with the future of this industry in the global economy, and to recommend potential actions by the federal government to support the maintenance of a robust aerospace industry in the 21st century.[3] In 2002, the Commission made recommendations to address these challenges.[4] Some of the recommendations proposed by the Commission included transforming the national air transportation system, creating a U.S. space exploration imperative, creating a government-wide management structure to support aerospace, establishing a level playing field for the United States in global markets, promoting the growth of the U.S. aerospace workforce, and increasing government investment in aerospace research and development (R&D).

You asked us to determine the status of federal actions that address the Commission's recommendations. Accordingly, this report focuses on the following questions: (1) To what extent have federal agencies addressed selected Commission recommendations? (2) What challenges remain in addressing these recommendations?

To address these two questions, we obtained and analyzed information from a variety of sources. We reviewed the relevant empirical literature to understand the circumstances under which the Commission was formed

[1]European Union, *Strategic Aerospace Review for the 21st Century (STAR-21*) (Brussels, Belgium: July 2002).

[2]European Union, *European Aeronautics: A Vision for 2020* (Brussels, Belgium: Jan. 2001).

[3]Section 1092 of Pub. L. No. 106-398, Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001.

[4]Commission on the Future of the United States Aerospace Industry, *Final Report* (Arlington, Va.: Nov. 2002).

and to develop the context and perspective of the issues facing the aerospace industry. We interviewed five of twelve former Commission members and the former Commission's executive director to obtain their opinions on which of the specific recommendations are the most important. Since each of the former Commissioners is an expert in specific aerospace issues the Commission examined, we selected these former Commissioners to ensure coverage of all Commission recommendations. Using their opinions and our research, we selected recommendations that address transforming the national air transportation system, creating a U.S. space exploration imperative, creating a government-wide management structure to support a national aerospace policy, establishing a level playing field for the United States in global markets, promoting the growth of the U.S. aerospace workforce, and increasing government investment in aerospace R&D. To determine the extent to which federal agencies addressed the selected recommendations and the challenges that remain, we interviewed officials from FAA; the Departments of Defense (Defense), Labor (Labor), and Transportation (DOT); the National Aeronautics and Space Administration (NASA); the White House Office of Science and Technology Policy (OSTP); private aerospace companies; and industry associations. In addition, we analyzed agency budget documents, strategic plans, briefings on federal agency actions, and our past work describing challenges that agencies face in implementing the selected recommendations. With the assistance of the National Academy of Sciences, we identified experts in the fields of national air transportation systems, U.S. space exploration, government aerospace management structure, U.S. aerospace workforce and education, and aerospace R&D. We then interviewed these experts to obtain their views about the extent to which federal actions have addressed the selected Commission recommendations, and about the challenges that lie ahead. These experts are listed in appendix I. We did not analyze the validity of the Commission's recommendations, and our work does not take a position on, or represent an endorsement of, the recommendations. We conducted our work from August 2005 through September 2006 in accordance with generally accepted government auditing standards. Additional information on our scope and methodology appears in appendix I.

Results in Brief

Federal agencies have taken actions that address selected Commission recommendations to varying degrees, from establishing new offices, programs, and policies to changing existing programs or policies; however, the actions the agencies have taken are still in the early stages of implementation. For example, the Commission's recommendation to establish a federal interdepartmental group to plan a new, highly

automated air traffic management system was addressed by the creation of the Joint Planning and Development Office (JPDO), which consists of seven federal agencies, including FAA, NASA, and Defense. However, JPDO faces challenges in leveraging partner agency resources and maintaining commitment from nonfederal stakeholders as it moves forward in planning the new air traffic management system. In addition, the President issued a new space exploration policy and NASA created a directorate to implement the policy, realigning some programs and funds to do so. Both the new policy and the directorate address the broad Commission recommendation to create a space imperative. Other new efforts include a jobs training initiative and education programs that address the broad Commission recommendation to promote the growth of the U.S. aerospace workforce. Labor and the Department of Education have provided grant funding for these efforts, however, there are questions about the impact of the grants. Changes to existing programs include NASA's restructuring of its aeronautics research program, which addresses the specific Commission recommendation to increase the federal focus on long-term aerospace research; FAA's revisions to its rule making and airport environmental review procedures, which address the specific Commission recommendations to streamline the regulatory and airport review processes; and FAA's attempts to increase the U.S. presence in international aviation partnerships, which addresses the specific Commission recommendation to commit to international partnerships. Federal agencies have taken few, if any, actions to address other Commission recommendations such as reforming exports control policies and establishing a national aerospace policy.

A number of challenges remain for federal agencies in further addressing the Commission's recommendations, including dealing with difficult budgetary trade-offs and collaborating on actions involving multiple agencies. Federal agencies may not give priority to programs that address Commission recommendations because of budget limitations. Such budgetary trade-offs are all the more likely if implementing a recommendation requires launching or expanding large, expensive programs. NASA has already realigned some programs that address the Commission's recommendations—such as the recommendation to create a U.S. space imperative—and, in so doing, has had to make some difficult budgetary prioritization decisions. Since multiple federal agencies are involved in the U.S. aerospace industry, a lack of coordination among federal agencies, aerospace companies, and universities could result in duplicating efforts and not leveraging resources efficiently. For example, our prior work has shown that coordination of federal science, technology, engineering, and mathematics education programs has been

limited, and that better coordination between federal agencies could help the agencies to better encourage students to pursue careers in science, technology, engineering, and mathematics. We provided a draft of this report to the Departments of Defense, Labor, and Transportation, NASA, and the Office of Science Technology Policy for their review and comment. The Department of Defense had no comments, and the other agencies generally concurred with the report, but provided clarifications and technical comments, which we incorporated as appropriate.

Background

The impact of the aerospace industry on the U.S. economy is significant, with the industry estimating $170 billion in sales and approximately 625,000 people employed in 2005.[5] The importance of this industry to the U.S. economy will continue to grow in the future. According to FAA, the U.S. commercial aircraft fleet is estimated to grow from 7,836 in 2005 to 10,677 in 2017. Both passenger capacity and cargo operations are expected to continue to grow, with passenger capacity in 2007 increasing by 4.6 percent and then increasing by an average of 4.2 percent per year until 2017. FAA estimates that over 1 billion passengers will use U.S. airports by 2015. Domestic cargo revenue-ton miles are projected to increase at an average annual rate of 3.2 percent until 2017, exceeding 23 billion. Furthermore, the U.S. aerospace industry consistently shows a foreign trade surplus—reaching $31 billion in 2004. Aerospace exports constituted 6.9 percent of the total value of U.S.-exported merchandise in 2004.

Role of Government and Industry in Aerospace Is Significant

The federal government is involved in many aspects of aerospace, such as civil aviation transportation management, national security, space exploration, and related R&D. FAA, NASA, and Defense are major federal agencies significantly involved in aerospace activities.[6]

- FAA is responsible for maintaining a safe and efficient national airspace system by managing the nation's air traffic control system, which comprises a vast network of radars; automated data processing, navigation, and communications equipment; and facilities. As manager of the air traffic control system, FAA provides services such as controlling

[5]Aerospace Industries Association, *Aerospace: Facts and Figures 2005-2006* (Arlington, Va.: 2005).

[6]Other federal agencies involved in the aerospace industry to some extent are the Departments of Commerce, Homeland Security, and State.

takeoffs and landings and managing the flow of traffic between airports. In addition, FAA serves as the national aviation regulatory authority and implements and enforces safety regulations that include certifications of aircraft, aircraft operations, and aviation pilots and mechanics.

- NASA is responsible for the nation's civil space and aeronautics efforts. In this role, NASA conducts human exploration of space, conducts R&D in aeronautics and space technologies, and conducts R&D to advance and communicate scientific knowledge. NASA's programs encompass a broad range of complex and technical activities—from investigating the composition and resources of Mars to providing satellite and aircraft observations of Earth for scientific purposes and weather forecasting.

- Defense is responsible for national security and purchases a variety of aerospace products from the private sector such as aircraft, satellites, missiles, space launch systems, and supporting products. Defense also manages a broad array of space activities, including the development of space launch vehicles and satellites used for communication; navigation; intelligence, surveillance, and reconnaissance; and weather monitoring.

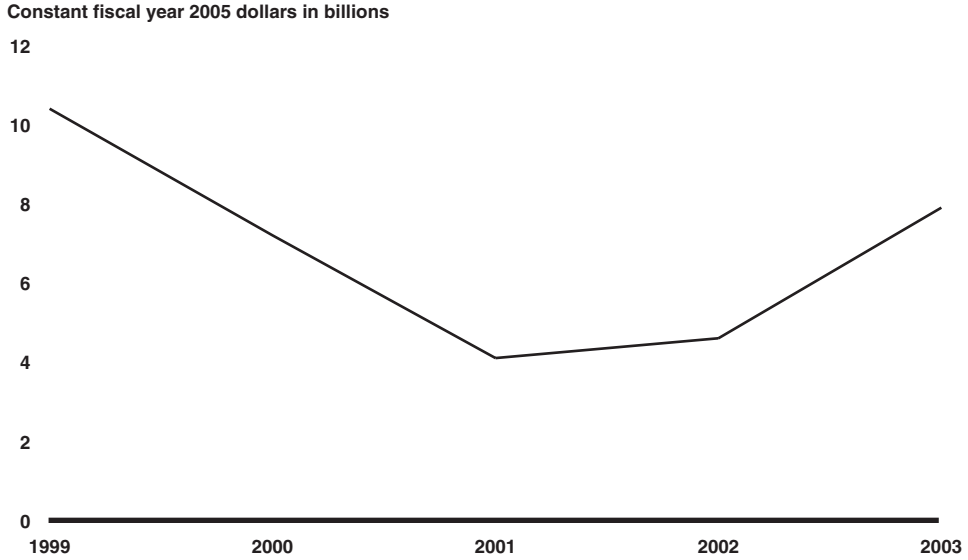
The private sector provides aerospace products and services. For example, U.S. companies manufacture aerospace products that include commercial and military aircraft, satellites, and air traffic infrastructure systems. Commercial airlines provide domestic and international aviation passenger service. Software and electronics companies produce avionics and other electronic systems that are used in all types of aerospace products. To provide these products and services, companies rely on a highly skilled workforce of approximately 625,000 employees, including manufacturing technicians, aerospace engineers, and scientists.

Government Funding of Aerospace R&D Is Significant, but Trends in Funding Differ among Agencies

R&D enables the advancement of aerospace technologies, and funding for it will continue to be necessary if the industry is to maintain its global competitiveness and meet future needs. Traditionally, the federal government has provided significant funding for aerospace R&D (see fig. 1). However, federal R&D investments in some areas of aerospace, like aeronautics, are in decline. For example, NASA estimates that its 2006 direct aeronautics R&D budget will decline by approximately 43 percent from 2002, the time of publication of the Commission report. Conversely, R&D funding is increasing in space exploration areas as well as defense-related areas such as ballistic missile defense and defense-related

aeronautics.[7] Additional information on federal government R&D funding trends appears in appendix II.

Figure 1: Federal Funding for Industrial R&D in the Aerospace Industry



Source: National Science Foundation.

Aerospace Industry Facing Multiple Challenges

Despite the economic importance of the aerospace industry, many challenges face both government and private industry in maintaining the industry's health. First, the current approach to managing air transportation is becoming increasingly inefficient and operationally obsolete. The government will be faced with transforming the U.S. air traffic management system to accommodate expected increases in demand while ensuring the continued safety and security of the flying public. Second, given the terrorist attacks of September 11, 2001, the U.S. government has had to reevaluate whether existing arms export-control policies support national security and foreign policy goals. Finally, the U.S.

[7]The Department of Homeland Security also funds a variety of R&D activities, including some related to aviation security. These activities are overseen by the Department of Homeland Security's Science and Technology Directorate. This directorate requested approximately $1 billion for fiscal year 2007, but these funds are primarily for homeland security-capabilities R&D.

aerospace workforce is aging and a significant percentage of the aerospace workforce will be eligible to retire by 2008. Therefore, the industry must attract, train, and retain new workers with the engineering, science, and technical capabilities it needs. But recent trends show declines in the future supply of such workers. For example, the Commission highlighted that the number of doctorate degrees awarded annually in engineering had declined by 15 percent from the mid 1990s.

Aerospace Commission Made Recommendations to Address Challenges

To confront these challenges, the U.S. Congress established the Commission and gave it a broad mandate to study the health of the aerospace industry and recommend actions that the U.S. government should take to ensure the industry's future health. Congress directed the Commission to take an integrated, long-term view of the entire aerospace industry from the perspective of government, industry, labor, and academia. Therefore, its 12 members came from manufacturing firms, industry groups, aerospace consultancies, financial institutions, and labor groups with expertise in space and aeronautics in both civil and defense areas. In 2002, the Commission issued its final report on the major challenges facing the U.S. aerospace industry and recommended actions to address these challenges. The Commission's recommendations covered a wide variety of aerospace issues and included both broad government policy recommendations and specific actions for individual federal agencies.[8] For example, one recommendation called for the United States to pioneer new frontiers in aerospace while another recommendation specifically called for FAA to reform its certification process. Table 1 provides a summary of some of the major issue areas identified by the Commission report, as well as some challenges and nine broad recommendations made by the Commission to address the issues.

[8]Federal agencies were not required to implement any of the Commission's recommendations.

Table 1: Summary of Aerospace Commission Recommendations

Area addressed	Sample of challenges identified by the Commission	Summary of broad recommendation made by the Commission
Aerospace vision	U.S. leadership in the global aerospace industry is in jeopardy, in part because the U.S. aerospace sector lacks capital investment, innovation, and capacity for growth; and foreign competitors are increasingly implementing policies to gain global market share in commercial aviation.	The United States should pioneer new frontiers in aerospace technology, commerce, and exploration.
National air transportation system	America's air transportation system faces serious challenges; the commercial air transport system is becoming unpredictable because the current air traffic system is approaching gridlock, regulatory processes have failed to keep pace with rapidly evolving technologies, and environmental limits on noise and emissions restrict airport runway development.	Transformation of the U.S. air transportation system should be a national priority.
U.S. space policy	The nation faces limitations to space progress, such as the significant expense to get to orbit, a hostile and highly limited environment once in orbit, and lack of a strong public advocacy for moving ahead.	The United States should create a space imperative, through government and private sector partnerships, to enhance national security, stimulate the economy, explore the universe, and open up space for new commercial opportunities.
National security	Today's military capabilities are robust, but at significant risk. They rely on platforms and an industrial base—measured in both human capital and physical facilities—that are aging and increasingly inadequate.	The United States should adopt a policy that invigorates and sustains the aerospace industrial base and includes removing barriers to international sales of defense products, removing barriers to defense procurement of commercial products and services, and transferring defense technology to the civil sector.
Government-wide management structure	The health and future of the aerospace industry will depend on the federal government being able to efficiently and effectively serve as leader, customer and operator, facilitator, and investor.	The federal government should establish a national aerospace policy and promote aerospace by creating a government-wide management structure.
Open and fair global markets	Foreign governments or coalitions of countries are distorting the aerospace market through policies, regulations, or subsidies that provide foreign competitors with a competitive advantage.	Federal regulations and policies should be reformed to enable the movement of products and capital across international borders on a fully competitive basis and to establish a level playing field for U.S. industry in the global marketplace.
A new business model for the aerospace sector	The aerospace industry has been characterized as a low-growth sector, chronically hampered by high cyclicality, low margins, revenue instability, and inadequate returns on investment, amplified by the uncertainty in the government budgeting and acquisition process.	A new business model, with increased and sustained government investment and the adoption of policies that stimulate the flow of capital into the industry, should be designed to promote a healthy and growing U.S. aerospace industry.
U.S. aerospace workforce	There is a major workforce crisis in the aerospace industry. Over 600,000 scientific and technical aerospace jobs have been lost since 1998, and these losses, coupled with pending retirements, represent a loss of skill, experience, and intellectual capital to the industry.	The nation should immediately reverse the decline in, and promote the growth of, a scientifically and technologically trained U.S. aerospace workforce.

Area addressed	Sample of challenges identified by the Commission	Summary of broad recommendation made by the Commission
U.S. aerospace R&D	The lack of sufficient and sustained public funding for research and associated infrastructure for research, development, testing, and evaluation limits the nation's ability to address critical national challenges and to enable breakthrough aerospace capabilities.	The federal government should significantly increase its investment in basic aerospace research, which enhances U.S. national security; enables breakthrough capabilities; and fosters an efficient, secure, and safe aerospace transportation system.

Source: Commission report.

Additionally, since the publication of the Commission report, other studies by such organizations as the National Academy of Sciences and the National Institute of Aerospace also provided information on the importance of the aerospace industry, along with challenges and recommendations for addressing the issues.[9]

Federal Agencies Have Addressed Commission Recommendations to Varying Degrees through Different Types of Actions

The federal government has addressed a number of the Commission's recommendations; however, the extent to which it has done so varies significantly across the individual recommendations. Figure 2 identifies the key federal entities that have taken steps to address the recommendations or, because of their missions, were identified by the Commission as the entities that would be responsible for addressing the recommendations.

[9]National Research Council of the National Academy of Sciences, *Decadal Survey of Civil Aeronautics: Foundation for the Future* (Washington, D.C.: 2006) and the National Institute of Aerospace, *Responding to the Call: Aviation Plan for American Leadership* (Washington, D.C.: Apr. 2005).

Figure 2: Key Federal Entities for Selected Recommendations

Recommendation	Key federal entities
Transform the U.S. air transportation system as a national priority	Commerce, Defense, DOT, FAA, Homeland Security, JPDO, NASA, OSTP
Create a space imperative	Defense, NASA
Establish a national aerospace policy and promote aerospace	Congress, Office of Management and Budget, OSTP, White House
Enable the movement of products and investment across international borders on a fully competitive basis	Commerce, Congress, DOT, FAA, State
Reverse the decline in, and promote the growth of the U.S. aerospace workforce	Defense, DOT, Education, Labor, NASA
Enable breakthrough aerospace capabilities through focused federal R&D efforts	Defense, FAA, NASA

Source: GAO analysis.

Former Commissioners and experts with whom we spoke generally agreed that the federal government's efforts to transform the national airspace system was the most significant action that addresses a Commission recommendation—in particular, the establishment of JPDO as an interagency office. These former Commissioners and experts also cited the President's Vision for Space Exploration,[10] which addresses the Commission's recommendation that the United States create a space imperative to explore and exploit space to ensure national and planetary security, economic benefit, and scientific discovery. In addition, federal agencies have started addressing the workforce issue through a new jobs training initiative. According to our research[11] and the opinions of former Commissioners and aerospace industry officials, the federal government has not taken any significant action to address the recommendations to change the current export control policy. In addition, there has been no action taken by the federal government to establish a national aerospace policy.[12] While many of these federal actions address the Commission's

[10]NASA, *The Vision for Space Exploration* (Washington, D.C.: Feb. 2004).

[11]GAO, *Defense Trade: Arms Export Control System in the Post-9/11 Environment*, GAO-05-234 (Washington, D.C.: Feb. 16, 2005).

[12]While separate space and aeronautic policies have been developed, or are in the process of being developed, there is no single national aerospace policy.

recommendations, some agency officials indicated that some federal actions predate the Commission report and therefore do not represent a direct response to the Commission's recommendations. Figure 3 summarizes the extent to which federal agencies have taken actions—such as publishing new policies or establishing new offices—that address some of the Commission's recommendations. While this information summarizes federal actions, it does not evaluate how well these actions have been implemented. See appendix III for additional federal actions that address selected aerospace Commission recommendations.

Figure 3: Extent to Which Selected Recommendations Have Been Addressed

Recommendation	No action or a contrary action has been taken	Internal or external discussion has started	Plans or policies have been developed and published	Plans or policies are being implemented	Plans or policies have been implemented and performance has been evaluated
Transform the U.S. air transportation system as a national priority					
Establish a federal inter-departmental group to plan a new, highly automated air traffic management system			✓		
Streamline regulatory processes				✓	
Streamline airport and runway development processes				✓	
Create a space imperative					
Sustain commitment to science missions in space				✓	
Establish a national aerospace policy and promote aerospace	✓				
Enable the movement of products and investment across international borders on a fully competitive basis					
Commit to international partnerships				✓	
Reform U.S. export control policies		✓			
Reverse the decline in, and promote the growth of the U.S. aerospace workforce					
Establish programs that support training of aerospace workers				✓	
Make investments in math, science, and technology education of Americans				✓	
Enable breakthrough aerospace capabilities through focused federal R&D efforts					
Establish national demonstration goals	✓ (space)		✓ (aeronautics)[a]		
Increase federal investment in aerospace research	✓ (aeronautics)			✓ (space)	

Source: GAO analysis.

[a]Refers to the JPDO demonstration goals identified in its next generation air transportation system integrated plan.

New Federal Programs and Policies Have Addressed Some Commission Recommendations

Congress and federal agencies have established new offices, programs, and policies that address a number of the Commission's recommendations in the areas of transforming the U.S. air transportation system, creating a U.S. space imperative, and promoting the U.S. aerospace workforce. However, the actions the agencies have taken are still in the early stages of implementation.

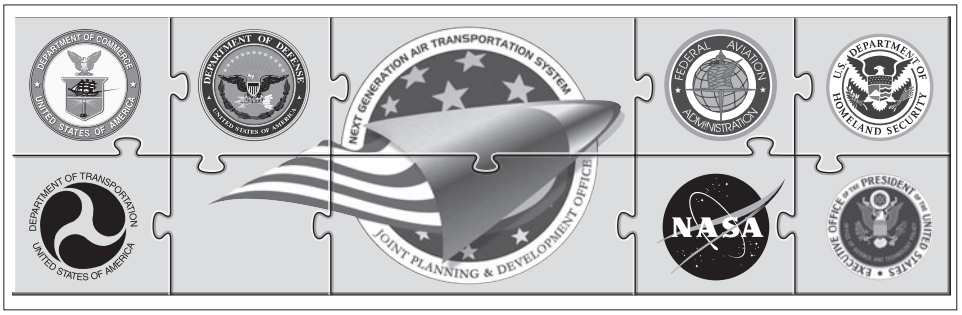
Creation of JPDO Addresses Recommendation to Transform the U.S. Air Transportation System, but Funding Concerns Remain

In 2003, Congress passed the Vision 100—Century of Aviation Reauthorization Act (Vision 100),[13] which created JPDO within FAA to plan work related to the creation of the next generation air transportation system (NGATS). The Commission identified the current air traffic management system as severely limited in its ability to accommodate America's growing need for mobility, and that the design, development, and implementation of a next generation air traffic management system will be an exceedingly complex challenge. The Commission called for a federal inter-departmental group—working collaboratively with industry, labor, and other stakeholders—to be formed to plan this new system, and former Commissioners and experts agree that the creation of JPDO addresses this recommendation. JPDO consists of seven partner agencies: the Departments of Commerce (Commerce) and Homeland Security; Defense; DOT; FAA; NASA; and OSTP. (See fig. 4.) Additionally, JPDO has responsibility to consult with the public; to coordinate federal goals, priorities, and research activities with those of aviation and aeronautical firms; and to ensure the participation of nonfederal stakeholders from the private sector, including commercial and general aviation, labor, aviation R&D entities, and manufacturers. To date, JPDO has been funded by FAA and NASA.[14]

[13]Pub.L. No. 108-176 (Dec. 12, 2003).

[14]FAA's fiscal year 2007 budget request for R&D includes about $18 million for JPDO, which is supplemented by matching funds from NASA. NASA has committed to continuing this match in the future, according to a JPDO official. JPDO uses these funds to conduct planning and studies. Vision 100 authorized $50 million annually for 7 years for JPDO.

Figure 4: JPDO's Seven Partner Agencies



Source: GAO.

Vision 100 directed JPDO to develop an integrated plan for NGATS and to include in the plan, among other things, a description of the demand and required performance characteristics of the future system, as well as a high-level, multi-agency roadmap and concept of operations for the future system.[15] NGATS is needed to avoid congestion and costly delays, provide adequate security and environmental safeguards, and accommodate a projected tripling of demand for air traffic services by 2025. This is a significant challenge given that these new capabilities must be deployed seamlessly while the current system continues to operate. (See app. IV for more information on JPDO.)

We found that JPDO has made progress in organizing itself and incorporating federal and nonfederal stakeholders; it has also set forth a vision for NGATS and strategies for attaining that vision.[16] Furthermore, JPDO has engaged in practices to facilitate the federal interagency

[15]As directed by Vision 100, the FAA Administrator provided this integrated plan to Congress in December 2004. JPDO, *Integrated National Plan for the Next Generation Air Transportation System* (Dec. 2004). In March 2006, JPDO issued a progress report on the integrated plan, which provides information on JPDO's organization and activities, such as staffing integrated product teams that are discussed in appendix IV.

[16]GAO, *Next Generation Air Transportation System: Preliminary Analysis of the Joint Planning and Development Office's Planning, Progress, and Challenges*, GAO-06-574T (Washington, D.C.: Mar. 29, 2006); GAO, *Air Traffic Control: Status of the Current Modernization Program and Planning for the Next Generation System*, GAO-06-738T (Washington, D.C.: May 4, 2006); GAO, *Air Traffic Control Modernization: Status of the Current Program and Planning for the Next Generation Air Transportation System*, GAO-06-653T (Washington, D.C.: June 21, 2006); GAO, *Next Generation Air Transportation System: Preliminary Analysis of Progress and Challenges Associated with the Transformation of the National Airspace System*, GAO-06-915T (Washington, D.C.: July 25, 2006).

collaboration that is central to its mission. The partner agencies have agreed to a vision statement and eight strategies that broadly address the goals and objectives for NGATS. JPDO has also begun leveraging the resources of its partner agencies. To leverage human resources, JPDO has staffed its organization with partner-agency employees, although many of them work for JPDO on a part-time basis. To further leverage resources, JPDO conducted an interagency program review of its partner agencies' R&D programs to identify the work that could support NGATS, as well as identify areas for more effective interagency collaboration.

However, as it moves forward in planning the new air traffic management system, JPDO faces a challenge in continuing to leverage partner agencies' resources because JPDO is fundamentally a planning and coordinating body that lacks authority over the key human and financial resources needed to continue developing plans and system requirements for NGATS. Despite early successes in leveraging its partner agencies' resources and expertise for NGATS initiatives, JPDO may have difficulty continuing to do so because its partner agencies have a variety of missions and priorities in addition to NGATS. As a result, some experts questioned the ability of partner agencies to fully support the research needs of NGATS at planned levels. For example, the President's fiscal year 2007 budget request for NASA did not seek significant funding increases for aeronautics research to support NGATS.[17] JPDO's ability to leverage technical assistance and funding resources from its partner agencies will be further tested in 2008, when JPDO is planning technology demonstration projects related to NGATS. In addition, JPDO may have difficulty leveraging its partner agencies' resources and expertise because it does not yet have formal, long-term agreements with the agencies on their roles and responsibilities in creating NGATS. According to JPDO officials, they are working to establish memorandums of understanding signed by the heads of the partner agencies that will broadly define the partner agencies' roles and responsibilities at a high level. JPDO is also developing more specific memorandums of understanding with individual partner agencies that lay out expectations for support on NGATS components, such as information

[17]NASA's fiscal year 2006 budget provides $174 million for the Airspace Systems program, which, according to NASA, is aligned with NGATS-related airspace research needs. The President's proposed budget for fiscal year 2007 shows future funding for this program decreasing by more than 50 percent through fiscal year 2011. NASA officials noted that research in the Aviation Safety Program and Subsonic Fixed Wing project also support NGATS-related research in addition to contributing to broader national needs in military and civil aviation.

sharing through network-centric operations. Additionally, JPDO faces the challenge of convincing nonfederal stakeholders that the government is fully committed to NGATS because, in the past, the government has discontinued work on new technologies for the national airspace system, including one technology in which a nonfederal stakeholder had already invested.

Issuance of a New Space Exploration Policy and Creation of a New NASA Office Addressed the Recommendation to Create a U.S. Space Imperative, but May Negatively Affect Other NASA Programs

The President's issuance of a national space exploration policy in January 2004, which calls for the human exploration of the Moon and Mars, and NASA's formation of a new mission directorate for space exploration programs, address the Commission's recommendation to create a U.S. space imperative. According to the Commission, the United States is in danger of losing its global leadership in space exploration, in large part because it lacks strong public advocacy for the nation's space program, whereas foreign countries are aggressively pursuing space exploration as a significant strategic and economic asset. Experts believe that the President's space exploration policy and NASA's new directorate address the Commission's concern. To achieve the policy's objective, NASA formed the Exploration Systems Mission Directorate to consolidate separate exploration-related capabilities within one organizational unit[18] and thereby enhance their cooperation. The new directorate conducted a study[19] to devise a plan for supporting the technologies and infrastructure needed to meet the new space exploration policy. Released in November 2005, the study recommended that NASA focus on the near-term activities needed to complete the International Space Station and then focus on the longer-term activities needed to implement its moon missions. The centerpiece of the longer-term activities is a program to accelerate the development of a new Crew Exploration Vehicle and Crew Launch Vehicle, to replace the shuttle. The exploration directorate restructured its programs and, as of fiscal year 2007, the three programs under the exploration directorate will be the Constellation Systems program,[20] the

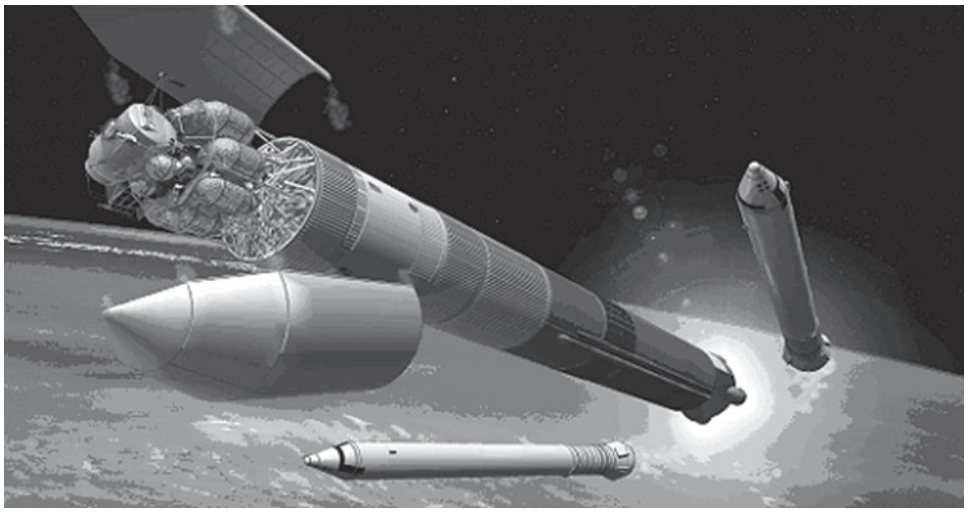
[18]Former programs of the Biological and Physical Research Enterprise merged with Exploration Systems on August 1, 2004.

[19]NASA, *NASA's Exploration Systems Architecture Study* (Washington, D.C.: Nov. 2005).

[20]The Constellation Systems program will develop, demonstrate, and deploy the collection of systems that will enable sustained human exploration of the Moon and Mars. These include the Crew Exploration Vehicle for the transport and support of human crews traveling to low Earth orbit and beyond, as well as launch vehicles for transport of the Crew Exploration Vehicle and cargo to low Earth orbit, and any ground or in-space support infrastructure for communications and operations.

Exploration Systems Research and Technology program,[21] and the Human Systems Research and Technology program.[22] NASA officials stated that research and technology projects have been aligned to support the new space exploration policy.

Figure 5: Proposed Cargo Launch Vehicle with Lunar Lander Is an Example of Aerospace R&D



Sources: NASA; John Frassanitio and Associates.

Aerospace experts reported that they believe NASA's focus on implementing the space exploration policy's goal of returning to the Moon and sending human missions to Mars negatively affects other space exploration projects that have significant scientific benefits. For example, in the fiscal year 2007 budget request, NASA announced cuts and delays in a number of projects in areas such as space crew health research, electric propulsion systems, and weather-monitoring systems. While experts and industry officials generally thought that NASA's space exploration policy addresses the Commission recommendation, they were concerned about the negative impact of this new policy on other programs. For example,

[21]The Exploration Systems Research and Technology program's primary focus is solar system exploration. This program will include areas such as exploratory R&D of new high-leverage technologies and the development of nuclear technologies for power and propulsion.

[22]The Human Systems Research and Technology program focuses on ensuring the health, safety, and security of humans through the course of solar-system exploration.

one expert noted that NASA's cancellation of research projects that are not directly supporting the space exploration programs has already negatively affected research efforts at universities throughout the nation. With the loss of funding in certain areas, this expert noted, many graduate students have lost their grants and could potentially leave the aerospace field. Their departure could have a long-term impact on the nation's future ability to develop new technologies. In addition, a recent report by the National Academy of Sciences that reviewed NASA's plans for science programs over the next 5 years, concluded that NASA does not have the necessary resources to carry out the tasks of completing the International Space Station, returning humans to the Moon, sustaining capabilities in aeronautical research, and maintaining space and Earth science programs.[23]

The President's High Growth Job Training Initiative Addresses Recommendation on Promoting the Aerospace Workforce, but Questions Remain about Its Impact

Labor addressed the Commission's workforce recommendation to reverse the decline and support the training of the aerospace workforce by including the aerospace industry in the President's High Growth Job Training Initiative.[24] The initiative focuses on 14 high-growth industries.[25] Given estimates that 26 percent of the aerospace industry workforce will be eligible for retirement by 2008, the Commission was concerned about a loss of intellectual capital. While the Commission was unable to agree on any immediate solution, it maintained that U.S. policy must reaffirm the goal of stabilizing and increasing the number of jobs in the industry. The training initiative is a national grant program, started in 2003, that attempts to tailor local workforce investment activities to reflect the workforce needs of local employers. According to Labor officials, the aerospace industry was selected in large part because of its significant impact on the economy overall, as well as its impact on the growth of other industries. A primary focus of the initiative is to address the aerospace industry's aging workforce—with the subsequent loss of institutional knowledge, experience, and technical talent—by attracting young people into the field and building their skills. The grants are provided to projects designed to

[23]National Academy of Sciences, *An Assessment of Balance in NASA's Science Programs* (Washington, D.C.: 2006).

[24]The high growth initiatives provide federal funding to local workforce training programs in 14 high-growth business sectors that have been identified as potentially adding a substantial numbers of new jobs, or have emerging technologies that require new skill sets for workers.

[25]The targeted industries are: advanced manufacturing, aerospace, automotive, biotechnology, construction, energy, financial services, geospatial technology, health care, homeland security, hospitality, information technology, retail, and transportation.

address the industry's aerospace workforce needs while also helping workers find employment with good wages and career opportunities. For example, a number of projects are geared toward expanding the number of youth interested in aerospace and provide training for aerospace employment. As of June 2006, Labor had provided eight grants, totaling over $10 million, for aerospace projects. (See table 2.)

Table 2: Grants Awarded by Labor for Aerospace Workforce Projects

Recipient	Purpose	Date awarded	Amount
Community Learning Center, Inc., Texas	To train aerospace workers for new high-technology manufacturing processes	June 2001	$4,028,000[a]
Brevard Community College, Florida	To provide hands-on learning opportunities for students to develop technical aerospace skills and improve awareness of the skills required for aerospace careers	December 2004	99,000
Edmonds Community College, Washington	To develop an advanced aerospace technician curriculum, career ladders, and distance learning approaches associated with the Boeing 787 supply chain	December 2004	1,475,000
Florida Space Research Institute, Florida	To provide two aerospace mentors for 25 teachers in seven Florida counties to improve hands-on knowledge and awareness of the skills required for aerospace careers in Florida	December 2004	356,000
Houston-Galveston Area Council for the Gulf Coast Workforce Board, Texas	To reduce foreign visa worker dependency in several high technology, high skill aerospace job occupations on the Texas Gulf Coast	December 2004	1,000,000
Enterprise-Ozark Community College, Alabama[b]	To develop skilled aviation technicians in Alabama's aviation industry corridor	October 2005	1,637,000
Aerospace Development Corporation	To establish an aerospace workforce infrastructure that identifies and develops strategic solutions to state-level challenges in the five key aerospace states of Alabama, California, Colorado, Florida, and Texas	July 2005	1,899,000

Source: GAO analysis of Labor information.

[a]The Community Learning Center, Inc. received two grants, which we combined.

[b]This grant was awarded under the Community-Based Job Training grant program, which is a competitive grant program that increases the capacity of community colleges to train workers in key industries such as the aerospace industry.

While the initiative addresses the Commission's recommendation to promote the growth of the aerospace workforce, the experts with whom we spoke questioned whether this program will have a significant impact. One expert stated that, because the aerospace industry rapidly changes, these types of job training programs are replacing skills that may run the risk of becoming quickly outdated. Another expert said that, even with these types of government training programs, the business cycle is the major influence on the status of the aerospace workforce. As with any

other major industry, if there is not a strong demand for aerospace products, companies will be hard pressed to provide enough jobs to maintain a strong workforce. In commenting on a draft of this report, Labor officials noted that this initiative is designed to model innovative solutions and to leverage larger federal investment programs and partnerships with industry, education providers, and other stakeholders. Therefore, Labor officials believe that this initiative will be able to respond to the aerospace industry's changing competency and skill requirements. However, the initiative has not been evaluated, so its impact is unknown.

Federal Agencies Have Established New Education Programs, but Concerns Remain About Programs' Effectiveness

Congress and federal agencies have addressed the Commission's recommendation to invest in science, technology, engineering, and mathematics (STEM) education by establishing a number of programs designed to increase students' interest in STEM careers. The Commission believes that STEM education at all levels, from kindergarten through graduate school, needs government action and investment to ensure that the aerospace industry has access to a scientifically and technologically trained workforce. In 2005, we reported[26] that 13 federal civilian agencies[27] spent about $2.8 billion in fiscal year 2004 for 207 education programs designed to increase the number of students and graduates, or to improve the educational programs in STEM fields.[28] Since 2004, a number of new STEM education programs have been created. For example, the national Science and Mathematics Access to Retain Talent (SMART) grant program was created in 2006 to encourage students to enroll in STEM fields. This program provides up to $4,000 for each of 2 academic years for students in their third or fourth academic year of an undergraduate program at a 4-year degree-granting institution, who have maintained a cumulative grade point average of 3.0 or above and meet the eligibility requirements of the federal government's need-based Pell Grant program.[29] The Department of

[26]GAO, *Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*, GAO-06-114 (Washington, D.C.: Oct. 12, 2005).

[27]The 13 federal agencies are the Departments of Agriculture, Education, Energy, Homeland Security, and the Interior; Commerce; DOT; the Environmental Protection Agency; the Health Resources and Services Administration; the Indian Health Service; NASA; the National Institutes of Health; and the National Science Foundation.

[28]STEM fields cover degrees in many disciplines (including aerospace, aeronautical, and astronautical engineering) and occupations (including aerospace, electrical, and electronics engineers).

[29]The Federal Pell Grant Program promotes access to postsecondary education by providing need-based grants to low-income students.

Education expects to provide $790 million in SMART grants to over 500,000 students in academic year 2006–2007. In addition, under the Deficit Reduction Act of 2005, Congress established an Academic Competitiveness Council, chaired by the Secretary of Education, to identify, evaluate, coordinate, and improve federal STEM programs.[30] This council is composed of officials from federal agencies with responsibilities for managing existing federal programs that promote STEM education. As mandated, the council plans to identify all federal programs with a STEM focus, identify the target populations, determine the effectiveness of these programs, identify areas of overlap or duplication, and recommend ways to efficiently integrate and coordinate the programs. Congress directed the council to report its findings and recommendations by early 2007. Finally, in 2006, the President announced the American Competitiveness Initiative, which, over the next 10 years, would commit $50 billion to increase funding for research and $86 billion for R&D tax incentives to encourage innovation in science and technology, and to support math and science education. While it does not specifically refer to aerospace, the initiative calls for investing in key federal agency programs with objectives that include encouraging up to 30,000 math and science professionals to become adjunct high school teachers, creating a research base to improve instructional methods and materials for teaching math and science, and evaluating the impact of government-wide investments in math and science education. [31]

Although the federal government has spent billions of dollars on education programs in STEM fields, concerns remain about the effectiveness of the federal investment. For example, the reduction in NASA's education budget will result in the elimination of long-standing programs designed to reach education communities, both formal (e.g., students, teachers, education administrators, and institutions) and informal (e.g., museums, planetariums, and community organizations). Experts told us that, although the federal government is directing significant amounts of funds to educational programs, the goals and potential outcomes for the programs are unclear and decentralized, thereby raising questions about whether the funding is providing the most effective results. For example,

[30]Pub. L. No. 109-171 (2006).

[31]The American Competitiveness Initiative identified the National Science Foundation, the Department of Energy's Office of Science, and Commerce's National Institute of Standards and Technology as the federal agencies that will have investments in their core research activities doubled over the next 10 years.

we have reported[32] that fewer STEM education programs are targeted to elementary and secondary school teachers and students than to other targeted groups—such as graduate program students—even though a number of experts stated that STEM programs for these teachers and students can have the greatest benefits. The experts we interviewed believe that the focus should start at the primary school level to have a better chance of influencing students to seek careers in the aerospace industry.

Changes to Existing Programs Have Addressed Some Commission Recommendations

Agencies' efforts to revise strategies and procedures and to restructure existing organizations have addressed some Commission recommendations in the areas of aeronautics R&D, streamlining FAA procedures, and increasing U.S. presence in international aviation; however, experts and industry officials have emphasized that these changes can negatively affect other programs or be limited by external factors.

NASA's Aeronautics Program Focuses on Basic Research as Recommended by the Commission, but Has Not Adopted Recommended Technology Demonstration Goals

NASA addressed the Commission's recommendations to focus on basic research by restructuring the Aeronautics Research Mission Directorate to give greater priority to fundamental research.[33] However, the Commission also recommended specific technology demonstration goals, and the agency is moving away from demonstration projects that showcase such goals. The Commission reported that U.S. industry might fall behind foreign competitors in pioneering new aerospace technology if U.S. R&D investments continued to downplay basic research and were not focused on specific, breakthrough technology goals. To address this challenge, the Commission recommended that the United States pursue long-term basic research and specific technology demonstration goals. NASA's restructured Aeronautics Research Mission Directorate includes three research programs—Fundamental Aeronautics, Aviation Safety, and Airspace Systems—that replace previous programs in Vehicle Systems, Aviation Safety and Security, and Airspace Systems, respectively.[34] (See

[32]GAO-06-114.

[33]NASA uses the term "fundamental" to refer to research that includes continued long-term, scientific study in core areas such as physics, chemistry, materials, experimental techniques, and computational techniques to enable new capabilities and technologies for individual and multiple disciplines.

[34]In addition, NASA's aeronautics directorate plans to preserve key aeronautics test facilities, such as wind tunnels.

table 3.) Within the three research programs, the most significant change occurred within what is now the Fundamental Aeronautics program, which focuses on fundamental aeronautics research rather than on development projects. Airspace Systems' name remains unchanged, but it will now focus on NGATS and JPDO's research needs. According to NASA, these programs give priority to fundamental research that is applicable to a broad range of air vehicles, whereas in the recent past NASA emphasized bringing specific projects to higher technological maturity, often focusing on these narrowly defined demonstration projects and not on developing technology that would be transferable to other types of systems or projects.[35] NASA also has taken several actions to better solicit input from academia and industry, with the goal of facilitating the transfer of R&D to industry as a whole.[36] For example, NASA told us that as of August 2006, at least 110 universities had submitted proposals in response to research announcements that it issued in January 2006. In addition, the Commission recommended technology demonstration goals, such as reducing aviation transit time by 50 percent and engine emissions and noise by 90 percent, but NASA does not plan to adopt these goals or alternative narrowly defined technology demonstration goals, because its leadership believes that pursuing them can lead to scientifically unjustified research projects. For example, while the design for a vehicle could showcase one particular goal, such as reducing emissions, this design could perform poorly in another area, such as reducing engine noise. NASA leadership believes that to overcome these types of conflicting design requirements, NASA must use a more integrated approach, grounded in fundamental research that cuts across its core disciplines such as aerodynamics, acoustics, and combustion.

[35]Technology maturity is attained when a technology can be shown to work in an operational environment.

[36]The Commission report stated the Commission's belief that the U.S. aerospace industry must take a leadership role in transitioning government and university research into products and services. In reviewing a draft of this report, NASA officials stated that their restructured aeronautics program is directly aligned with the Commission's intent.

Table 3: Reshaped Strategy of NASA's Aeronautics Research Mission Directorate

Previous program	New program	New program's focus	Major changes between previous and new programs
Vehicle Systems	Fundamental Aeronautics	Conduct long-term research in the core competencies of aeronautics—such as propulsion, aerothermodynamics, and materials—that are applicable to a broad range of subsonic (both fixed- and rotary-wing), supersonic, and hypersonic air vehicles.	Program no longer focuses on the development of narrowly defined technology demonstration projects and directs attention to more fundamental research areas.
Aviation Safety and Security	Aviation Safety	Provide the capabilities and technologies needed to increase aviation safety given the revolutionary changes expected in air vehicles of the future. Work is "vehicle-centric" and focused on the safety needs of NGATS.	Aviation security is dropped from the research portfolio. If it continued this work, NASA believes it would duplicate efforts now under way by the Department of Homeland Security.
Airspace Systems	Airspace Systems	Develop future concepts, capabilities, and technologies that enable major increases in air traffic effectiveness, flexibility, and efficiency, as articulated for NGATS by JPDO.	Reshaped program integrates formerly independent programs and is directly aligned with supporting NGATS and JPDO.

Source: GAO analysis of NASA data.

NASA's restructuring of the Aeronautics Research Mission Directorate matches the Commission's recommendation to emphasize basic research, but reduced funding of demonstration projects might leave technologies too underdeveloped for easy adoption by industry. While NASA's reshaped strategy focuses more on basic research, as recommended by the Commission, NASA has less funding for demonstration projects and partnership projects with industry and academia. Experts commented that these demonstration projects are an important mechanism for technology transfer and in focusing on fundamental research, NASA will not be able to develop new technologies to the same level of maturity as in the past. NASA noted that it will continue to conduct flight test demonstrations with other federal agencies, such as Defense. Our prior work has found that technologies that have demonstrated a high level of maturity are more likely to meet cost, schedule, and performance requirements during product development. Similarly, our prior work and several experts with whom we spoke indicated that, as a result, industry would be less likely to further develop these new technologies for commercial and government use and, therefore, for example, implementation of NGATS could be delayed. While experts agreed that the budget decline will negatively affect aeronautics R&D, they disagreed about the importance of adopting the Commission's specific demonstration goals. One expert stated that the Commission's recommended demonstration goals are best interpreted as ideals for the future, whereas another expert endorsed pursuing them. Still another expert stated that focusing on basic research instead of

demonstration projects makes sense in the face of the directorate's declining budget, since demonstration projects are expensive (see app. II for further information on R&D funding). Finally, a recent study by the National Academy of Sciences notes that declining budgets for aeronautic research pose a challenge to civil aeronautics research, but recommends that research should focus on strategic objectives, themes, and high-priority research and technical challenges, regardless of funding levels.[37]

FAA's Modifications of Regulations and Procedures Address Recommendations; however, External Factors Might Limit Further Streamlining

A variety of FAA actions have addressed the Commission's recommendations to revise rule-making procedures and streamline airport and runway development processes. These recommendations reflect the Commission's concerns that lengthy rule-making procedures have delayed the issuance of new rules and that delays in airport environmental reviews for new runways have hindered efforts to enhance airport capacity. FAA actions include conducting monthly briefings for senior policymakers on significant rules, creating compensation incentives for senior executives that are tied to the timely completion of rules, and developing a performance standard that requires 80 percent of all initiated rules to be cleared by the FAA Administrator within 90 days of their originally scheduled completion date. Furthermore, DOT's Chief of Staff and Deputy Secretary conduct quarterly meetings with the FAA Administrator to review the status of each proposed rule. In addition, to help expedite the process for airport development projects and reduce the average of 10 years it takes to plan and build a new runway, FAA is taking steps to streamline airport environmental reviews.[38] For example, FAA issued an order in April 2006 to expedite reviews of airport projects that includes the ability to prioritize the review of certain airport projects; promote public review and comment; manage time lines during the review; and expedite coordination between those federal, state, and local agencies involved in airport environmental reviews in order to reduce undue delays during the review process. In addition, to reduce delays in environmental review work caused by insufficient staff, FAA is reallocating FAA staff resources and increasing the use of consultants.

While some FAA actions have addressed the Commission's recommendations to revise rule-making procedures and streamline

[37]National Research Council of the National Academy of Sciences, *Decadal Survey of Civil Aeronautics: Foundation for the Future* (Washington, D.C.: 2006).

[38]GAO, *Aviation Infrastructure: Challenges Related to Building Runways and Actions to Address Them*, GAO-03-164 (Washington, D.C.: Jan. 30, 2003).

environmental airport reviews, we have reported that factors such as legal and policy requirements and local politics might limit FAA's ability to further streamline these procedures. In a 2003 analysis of 32 runway projects, we noted significant challenges to reducing runway project delays, including the difficulty of reaching consensus among stakeholders on the need for runways; complying with numerous overlapping federal, state, and local environmental laws; mitigating the impact of aircraft noise on the surrounding community; and challenges faced during the runway design and construction phase.[39] Former commissioners and experts supported our prior research. For example, one aerospace expert said that legal requirements that apply to the rule-making process, such as the requirement for periods of public comment, create unavoidable delays. Another expert said that FAA is limited in its ability to reduce the time it takes to issue rules because rules are designed to ensure the safe operation of aircraft and public safety considerations have to take priority over reducing the time it takes to issue the rule. Some experts also said that FAA is limited in its ability to further streamline new airport runway reviews. For example, one expert noted that unavoidable delays often occur when local public and political opposition to runway development leads to court proceedings.

Agencies are Making Efforts to Address the Commission's Recommendation to Increase U.S. Presence in International Aviation

FAA and JPDO have made efforts to address the Commission's recommendation to increase the U.S. commitment to the development of global aviation standards and the establishment of international partnerships for global air traffic management systems. The Commission found that some foreign countries have established domestic standards that provide a competitive advantage for those countries' national companies, and although other governments have actively sought global leadership in international standard-setting bodies, such as the International Civil Aviation Organization (ICAO),[40] the United States has not devoted enough resources and is, therefore, losing its position as the de facto standard setter. FAA has supported several efforts to increase the U.S. commitment to, and involvement in, the development of global aviation standards by increasing its presence at ICAO. ICAO allocates positions within its organization to national citizens from all its member organizations and currently has allocated 31 positions to the United States.

[39]GAO-03-164.

[40]ICAO is a United Nations agency that sets international standards on civil aviation for 188 member states. The organization addresses fundamental issues ranging from air navigation and capacity to emerging environmental concerns such as engine noise and emissions.

To ensure that qualified U.S. candidates apply for these positions, FAA has supported a number of activities, including outreach efforts, incentive pay programs, and a fellowship program. For example, FAA has conducted outreach efforts at the staff level to increase awareness of international opportunities at ICAO. Senior FAA officials have given speeches and presentations at major agency functions, such as the Hispanic Coalition and the Professional Women's Air Traffic Control Organization. In 2003, FAA established the FAA/ICAO Fellowship Program, which sends FAA employees to work at ICAO for up to 12 months. Since the FAA/ICAO Fellowship Program started, six FAA employees have served as fellows and one of these fellows was subsequently hired by ICAO as a full-time employee for a 2-year position. JPDO has also worked to develop international partnerships—including partnerships with China, East Asia, and Europe—to promote the global harmonization of air traffic management systems.[41] The goal is to harmonize equipment and operations globally and advocate for the adoption of U.S.-preferred transformation concepts, technologies, procedures, and standards. For example, JPDO officials have noted the need to work toward harmonization with the Single European Air Traffic Management Research Program (SESAR), a major initiative to modernize the airspace system of the European Union. In July 2006, FAA announced that it had signed a memorandum of understanding with the European Union that identifies specific areas of cooperation.[42]

While FAA has made efforts to increase the U.S. presence at ICAO and develop partnerships, the majority of U.S. positions at ICAO are still unfilled, and in some areas, cooperation does not appear to be fully developed. FAA faces difficulty in filling the allocated positions for reasons beyond its control. For example, while FAA can recruit applicants, it does not make the final hiring decision. Despite FAA's efforts to fill the positions allocated to the United States at ICAO, as of December 2005, only 13 of the 31 allocated positions were filled. While FAA and JPDO are planning cooperative activities, our research has identified several areas where coordination does not appear to be fully developed. For example, we have reported that the SESAR and NGATS initiatives, despite their

[41]JPDO has a global harmonization integrated product team, led by managers from the Air Traffic Organization's Operations Planning Services International and FAA's Office of International Aviation.

[42]The areas of cooperation include regulations, standards, and procedures; coordination with international organizations; R&D; and civil and military air traffic management issues.

similarities, do not have coordination activities such as peer reviews of relevant research, cooperation on safety analysis (such as through the pooling of accident data), or validation of technologies.[43] It is possible that greater cooperation and exchange between NGATS and SESAR might develop once planning has progressed to the development and validation stage.

Limited Streamlining of U.S. Export Control Licensing Procedures Address the Commission's Recommendation; however, the Export Control Policy Has Not Fundamentally Changed

Some limited federal initiatives, primarily designed to streamline export licensing procedures, address aspects of the Commission's recommendation to reform regulations and policies to enable the movement of goods across borders on a fully competitive basis. According to the Commission, the current approach to U.S. export control is counterproductive to national security interests and the vitality of the U.S. aerospace industry. The Commission recommended streamlining U.S. export licensing systems and reforming export control policy. Commerce regulates exports of dual-use items—that is, items with military and civilian uses—and the Department of State regulates arms exports.[44] There are many aerospace products, such as commercial aircraft frames and components, which are designed for both civilian and military uses and are therefore licensed as dual-use items, while other aerospace products, such as precision-guided air-to-surface missiles, are designed for military use and would be licensed by State. State has implemented, through regulation and guidance, initiatives primarily designed to streamline and expedite the processing of export license applications. For example, in January 2004, State officially implemented a Web-based license application submission and review system that allows companies to electronically submit export authorization requests and supporting documentation for review. In February 2005, we reported that, although State initially received few applications through this system, officials noted greater use of the system after 1 year as well as reduced median processing times for electronically submitted export license applications.[45]

Although State has implemented initiatives to streamline the arms export control licensing process, overall, the export control policy has not undergone fundamental changes since the Commission published its

[43]GAO-06-738T.

[44]Commerce licenses dual-use items under Executive Order 13222 (66 Fed. Reg. 44025), and State licenses arms exports under the Arms Export Control Act (P.L. 90-629).

[45]GAO, *Defense Trade: Arms Export Control System in the Post-9/11 Environment*, GAO-05-234 (Washington D.C.: Feb. 16, 2005).

report. In 2005, we reported[46] that, although the system itself remains basically unchanged, new trends have emerged in the processing of arms export cases.[47] Median processing times[48] for all arms export cases declined between fiscal year 1999 and fiscal year 2002, but began increasing in fiscal year 2003; this upward trend continued into the first 7 months of fiscal year 2004. Furthermore, Commerce has not made fundamental changes to the dual-use export control system.[49] Attempts have been made to change the legislation governing the U.S. export control system since the Commission published its report, but none have resulted in new export control legislation.[50]

Federal Agencies Face Challenges in Addressing the Commission's Recommendations

Federal agencies will face a number of challenges in continuing to address the Commission's recommendations. These challenges include confronting difficult budgetary trade-offs and coordinating actions between multiple agencies and industry. Specifically, our work, federal officials, and industry experts indicated that budget constraints will require agencies to prioritize some programs that address certain recommendations at the expense of other programs. Furthermore, according to experts, a lack of coordination between federal agencies, private industry, and universities could impede the efficient advancement of the aerospace industry.

[46]GAO-05-234.

[47]Cases include applications for the permanent export of arms, the temporary export and import of arms, and agreements between U.S. industry and foreign entities to provide technical assistance or manufacturing capability, as well as requests for amendments to existing licenses and jurisdiction determinations.

[48]The median processing time is the point at which 50 percent of the cases took more time and 50 percent took less time. We are reporting the median processing time because average (or mean) processing times can be significantly affected by a small number of cases that had much longer review times than the majority of cases.

[49] GAO, *Export Controls: Improvements to Commerce's Dual-Use System Needed to Ensure Protection of U.S. Interests in the Post-9/11 Environment*, GAO-06-638 (Washington, D.C.: June 26, 2006).

[50]See H.R. 4572, 109th Congress and H.R. 4200, 109th Congress.

Agencies Face Challenges in Setting Funding Priorities for Efforts That Address Recommendations

Budget constraints, in all likelihood, will challenge agencies' efforts to address the Commission's recommendations, and require that some programs that address certain recommendations be given priority over other programs that address other recommendations.[51] Such budgetary trade-offs are all the more likely if implementing a recommendation requires launching or expanding large, expensive programs, such as the mission to Mars. Given the long-term fiscal challenges facing the United States and other current spending priorities that are unrelated to aerospace, it is unlikely that significant new sources of funding will be available for these programs, and overall departmental budgets may not expand. Consequently, agency officials are likely to face tough decisions prioritizing programs within their jurisdictions, and some programs that address recommendations will likely be scaled back, delayed, or cancelled. For example, the NASA Administrator testified in February 2006 that NASA cannot afford to fully fund all its programs. As a result, NASA's proposed fiscal year 2007 budget shows lower funding levels for a variety of areas such as aeronautics research and space shuttle operations.

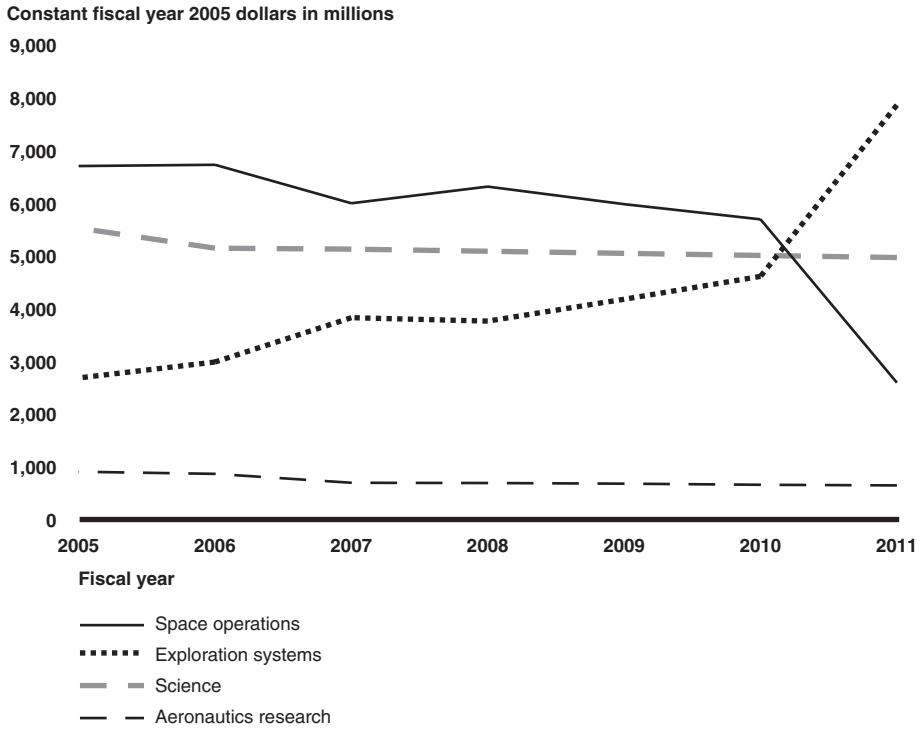
Within NASA, some programmatic realignment has already occurred in the course of implementing programs that address the Commission's recommendations, and, as a result, NASA has made some difficult budgetary prioritization decisions. For example, as discussed earlier, when NASA formed the Exploration Systems Mission Directorate to pursue the President's space policy, NASA aligned resources to complete the International Space Station and accelerate the development of new space vehicles to replace the space shuttle. In congressional testimony, the NASA Administrator stated that this reallocation of resources requires NASA to delay several NASA space science projects, and budget plans for upcoming years reflect an increasing priority for space exploration (see fig. 6).[52] Former commissioners and experts told us that, although NASA's space exploration activities are largely in line with the Commission's recommendation to create a space imperative, the resultant pull-back of NASA funds from other activities—like aeronautics research, which is projected to decrease almost 30 percent from $906 million in 2005 to $647 million (in 2005 dollars) in 2011, or support for basic scientific

[51]For additional information on federal budget constraints see GAO, *21st Century Challenges: Reexamining the Base of the Federal Government*, GAO-05-325SP (Washington, D.C.: Feb. 2005).

[52]Statement of Michael Griffin, Administrator, NASA, before the Committee on Science, House of Representatives, February 16, 2006.

research in aerospace at universities—was having negative effects. Likewise, the recent study of civil aeronautics research by the National Academy of Sciences notes that the continued decline of aeronautics research funding will challenge NASA's ability to conduct basic research needed for the future.[53]

Figure 6: Projected Trends in Major Aerospace-Related Missions within NASA, Fiscal Years 2005–2011



Source: GAO analysis of NASA's fiscal year 2007 Presidential Budget Request.

Note: This figure excludes NASA's budget for cross-agency support programs, such as education programs, and the Inspector General's Office. Space operations includes funding for the space shuttle and International Space Station. Exploration systems includes the budgets for developing new space vehicles such as the Crew Launch Vehicle and Crew Exploration Vehicle. Science includes funding for earth-sun, solar system, and universe programs. Aeronautics research is the total budget for the Aeronautics Research Mission Directorate.

[53]National Research Council of the National Academy of Sciences, *Decadal Survey of Civil Aeronautics: Foundation for the Future* (Washington, D.C.: 2006).

FAA and JPDO also face difficult budget prioritization questions that are likely to challenge their ability to address the Commission's recommendation to establish a new automated air traffic management system. For example, JPDO faces challenges in providing Congress with realistic cost estimates for the entire NGATS effort. While JPDO is responsible for the planning of NGATS, the implementation of NGATS will fall in large part to FAA. We reported[54] that FAA faces challenges in institutionalizing recent improvements in its management and acquisition processes, as well as in obtaining the expertise and resources needed to implement NGATS. We noted that transforming the national airspace system while the current system continues to operate will be an enormously complex undertaking, made more challenging by a difficult budgetary environment. Going forward, efforts by both FAA and JPDO to control costs and leverage resources will become ever more critical. Success depends on the ability of FAA and JPDO to define their roles and form a collaborative environment for planning and implementing the next generation system.

Agencies Face Challenges in Coordinating Efforts to Avoid Duplication and Inefficiency

According to experts and our work, better coordination among federal agencies, private industry, and universities could help advance the aerospace industry by reducing duplicative efforts and leveraging resources more efficiently. Such coordination is particularly important for STEM funding and JPDO, both of which involve multiple agencies. As previously discussed and as we reported in 2005, 13 federal civilian agencies reported funding 207 education programs in fiscal year 2004 to expand and improve STEM training.[55] Additionally, experts stated that, since these STEM programs are operated by the government and are designed to meet the needs of the federal government, industry, and research facilities, it is important that these key groups coordinate to develop an overall strategy. However, as we reported, there has been limited coordination between these programs. According to our prior report and experts with whom we spoke, the current lack of coordination is hindering improvements to STEM education.

[54]GAO-06-915T.

[55]GAO, *Higher Education: Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*, GAO-06-114 (Washington D.C.: Oct. 12, 2005). Among the agencies involved in these programs are NASA and FAA, which support degrees in aerospace and aeronautical engineering.

JPDO also faces the challenge of coordinating with its partner agencies in creating NGATS. According to our research, agencies must have a clear and compelling rationale for working together to overcome significant differences in their missions, cultures, and established ways of doing business. JPDO's integrated plan, among other things, provides a framework for institutionalizing collaboration among multiple federal agencies. JPDO is fundamentally a planning and coordinating body; therefore, it will be challenged to coordinate with its partner agencies, in part, because those agencies have differing missions and priorities. In addition, our work has shown that collaborating agencies should work together to define and agree on their respective roles and responsibilities, including how the collaborative effort will be led.[56] In JPDO's case, there is no formalized, long-term agreement on the partner agencies' roles and responsibilities in creating NGATS. According to JPDO officials, a memorandum of understanding that would define partner agencies' relationships was being developed, but has not been completed. It is particularly important for JPDO and FAA's Air Traffic Organization to define their respective roles and responsibilities, since both organizations are involved in planning the national airspace system's modernization and in coordinating the challenging transition from the current air traffic control system to NGATS.

Concluding Observations

Sustaining the nation's long-term commitment to science and technology—including aerospace science and technology—presents great opportunities to improve the quality of life, the performance of the economy, and the relationship of government to its citizens. Advances in aerospace technology in the United States have historically been fueled by combined public and private sector R&D, which have ensured the United States a global leadership position in the aerospace industry. However, a growing fiscal imbalance will require the nation to decide what level of federal spending it wants—including funding of aerospace R&D. Additionally, as other governments, such as the European Union, increase the use of government resources to pursue global leadership in the aerospace industry, the United States' preeminent position is being challenged.

[56]GAO, *Next Generation Air Transportation System: Preliminary Analysis of the Joint Planning and Development Office's Planning, Progress, and Challenges*, GAO-06-574T (Washington D.C.: Mar. 29, 2006).

While Congress did not establish any requirements to implement the Commission's recommendations, Congress and several federal agencies have taken significant actions that begin to address many of them. If Congress and federal agencies want to continue to address the Commission's recommendations, it will require leadership from all levels of government and the private sector. The establishment of JPDO and the President's space exploration policy are two major actions taken by the federal government, both of which will require the federal government to maintain long-term funding commitments. Our prior work has shown that one way to accomplish this is for federal agencies to continue to form collaborative environments for planning and implementing large cross-cutting programs such as NGATS. For example, JPDO has already moved to leverage other federal agency resources by conducting a review of its partner agencies' R&D programs to identify ongoing work that could support NGATS. Our prior work has also shown that the government's use of public-private partnerships can help to focus limited resources in programs that could provide the greatest benefit—both for the government and the private sector—and spread the risk across multiple stakeholders. The Commission emphasized the goal of developing stronger public-private partnerships, and some of the most significant actions that address the Commission's recommendations brought cross-government efforts together with industry to make advances with positive results.

Agency Comments

We provided a draft of this report to Defense, DOT, Labor, NASA, and OSTP for their review and comment. Labor and NASA provided written comments (see apps. V and VI). DOT and OSTP provided technical clarifications, which we incorporated into this report as appropriate. Defense had no comments on the draft report.

In response to the report's description of comments by experts concerning the President's High Growth Job Training Initiative, Labor emphasized that this initiative is designed to demonstrate innovative model solutions to these challenges, which may be leveraged and replicated by the larger publicly funded workforce investment system. The agency therefore believes that this approach will develop the ability to respond to the industry's changing competency and skill requirements. We revised the report to reflect Labor's viewpoint, but point out that since the initiative has not been evaluated, its impact is unknown.

NASA generally agreed with the report's contents, but provided several clarifying comments. For example, NASA identified additional actions it has taken that are aligned with Commission recommendations, such as

providing research grants to universities and NASA explained that it will continue to conduct flight test demonstrations with other federal agencies, such as Defense. We revised the report to include NASA's other actions. In addition, NASA noted that its aeronautics research budget is not projected to decline by 50 percent from fiscal year 2006 to fiscal year 2011, as stated in our report draft. We agree that 50 percent was an incorrect calculation and further agree with the budget numbers stated in NASA's letter. However, to evaluate budget trends over a number of years in real terms, we present budget numbers in the report in inflation-adjusted dollars. Therefore, when converted into 2005 dollars, the proposed aeronautics research budget will decrease by nearly 30 percent from $906 million in 2005 to $647 million (in 2005 dollars) in 2011. We corrected and clarified the report language.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 15 days after the report date. At that time, we will send copies of this report to interested congressional committees, the Secretaries of Defense, Labor, and Transportation; the Administrators of FAA and NASA; and the Director of OSTP. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-2834 or dillinghamg@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix VII.

Sincerely yours,

Gerald L. Dillingham, Ph.D.
Director, Physical Infrastructure Issues

Appendix I: Objectives, Scope, and Methodology

In considering the recommendations made by the Commission on the Future of the United States Aerospace Industry (the Commission), this report addresses the following research questions: (1) To what extent have federal agencies addressed selected Commission recommendations? (2) What challenges remain in addressing these recommendations?

The 2002 report by the Commission contains nine broad recommendations, each of which call for multiple actions by the federal government.[1] We selected six of these recommendations for review. To assist us in our selection, we interviewed five of the twelve former Commissioners—including the Commission's former Chair—and the Commission's former executive director, to obtain their views on the relative importance and potential impact of the recommendations. Since each of the former Commissioners is an expert in specific aerospace issues the Commission examined, we selected these former Commissioners to ensure coverage of all Commission recommendations. The six recommendations call for: (1) transforming the national air transportation system, (2) creating a U.S. space exploration imperative, (3) creating a government-wide management structure to support a national aerospace policy, (4) establishing a level playing field for the United States in global markets, (5) promoting the growth of the U.S. aerospace workforce, and (6) increasing government investment in aerospace research and development (R&D). We selected these recommendations according to the degree to which they were viewed as important by former Commission members and by us, and called for measurable agency actions.

To address our two research questions, we obtained and analyzed information from a variety of sources, including agency budget documents, reports, policies, legislation, regulations, strategic plans, briefings, and our own reports. We interviewed officials from the Federal Aviation Administration (FAA); the Departments of Defense (Defense), Labor (Labor), and Transportation (DOT); the Office of Science and Technology Policy (OSTP); and the National Aeronautics and Space Administration (NASA). We also visited NASA's Dryden Flight Research Center and Ames Research Center. In addition, we interviewed officials from the Aerospace Industries Association, Boeing, and Northrup Grumman to obtain their views on agency actions and challenges. Finally,

[1]Commission on the Future of the United States Aerospace Industry, *Final Report* (Arlington, Va.: Nov. 2002).

with the assistance of the National Academy of Sciences, we identified 15 experts in the fields of air transportation, space, aerospace policy and government structure, aerospace workforce and education, and aerospace R&D. We interviewed these experts to obtain their views on the extent to which the federal actions have addressed the selected Commission recommendations, and on the challenges that lie ahead. (Table 4 identifies the list of participating experts.)

Table 4: Experts Providing Input during Our Review

Expert	Area of expertise
Dwight Abbott, General Manager (retired), Systems Engineering Division, The Aerospace Corporation	• Space
Bill Ballhaus, President and Chief Executive Officer, The Aerospace Corporation	• Space
Jack Fearnsides, Senior Strategic Consultant to the President, Lockheed-Martin Air Traffic Management Company	• Air transportation • Aerospace policy and government structure
Mike Freeman, Vice President and Program Manager, Northrop Grumman	• Air transportation
Rich Golaszewski, Executive Vice President, GRA Incorporated	• Air transportation • Aerospace R&D
Bernard Grossman, Vice President for Education and Outreach, The National Institute of Aerospace	• Aerospace workforce and education
Hollis Harris, President and Chief Executive Officer (retired), World Airways	• Air transportation
Preston Henne, Senior Vice President for Programs, Engineering, and Test, Gulfstream	• Aerospace R&D
John LaGraff, Professor, Department of Mechanical and Aerospace Engineering, Syracuse University	• Aerospace workforce and education
John McMasters, Technical Fellow, The Boeing Company	• Aerospace workforce and education
George Muellner, Vice President and General Manager of Air Force Systems for Integrated Defense Systems, The Boeing Company	• Space
Bob Ravera, Consultant, RJR Aviation, LLC	• Air transportation • Aerospace policy and government structure
Dorothy Robyn, Senior Consultant, The Brattle Group	• Aerospace policy and government structure
Annalisa Weigel, Professor, Aeronautics and Astronautics, Massachusetts Institute of Technology	• Aerospace policy and government structure • Aerospace R&D
Dave Wisler, Manager of University Programs and Aero Technology Labs, GE Aircraft Engines	• Aerospace workforce and education

Source: GAO.

We did not analyze the validity of the Commission's recommendations, and our work does not take a position on, or represent an endorsement of, the recommendations, or the actions that address them. We conducted our work from August 2005 through September 2006 in accordance with generally accepted government auditing standards.

Appendix II: Aerospace Research and Development Funding Trends

Aerospace R&D includes a wide range of activities, from basic scientific research to the development of new technologies in increasingly diverse fields of study. Federal dollars continue to be a significant contributor to U.S. aerospace R&D, but in recent years, the federal role has declined relative to industry funding. The three major federal agencies that support aerospace R&D— Defense, NASA, and FAA—have different priorities and missions that are reflected in their respective R&D portfolios. Defense's R&D budget is greater than any other agency—with a large majority of its R&D funds supporting development projects—and its R&D budgets for air and space R&D has increased in recent years. NASA's current prioritization of space exploration has driven R&D funding priorities, and under current plans NASA will provide more funding for development activities than for basic and applied research. Likewise, NASA's projected funding for aeronautics research and science is in slight decline. FAA, with the smallest R&D budget of the three agencies, focuses funding on the development of the next generation air transportation system (NGATS), but its R&D funding has also declined.

Aerospace R&D Includes a Wide Range of Activities

Aerospace R&D includes a wide range of activities such as basic research, applied research, and development. Basic research works to expand fundamental knowledge in areas such as physics, chemistry, and mathematics without specific applications in mind; however, it may include activities with broad applications. Applied research aims to gain knowledge applicable to solving specific and identified needs, building on the general work of the basic sciences. Applied aerospace research includes activities to develop better propulsion and power technology, advanced spacecraft technology, and crew and personnel protection technology. Development projects use the knowledge and understanding developed by researchers to build new, or improve existing, systems. New military weapons systems, a replacement for the space shuttle, and new commercial aircraft are all examples of major development projects.

Increasingly, R&D in areas not traditionally associated with aerospace, such as computer software, has applicability to the sector. At the same time, long-established areas for aerospace research may bring benefits to other economic sectors. For example, advances in software might benefit new flight control systems and have applications to banking, or new ceramic materials developed for airplanes might be used in automobiles. Researchers do not always know beforehand where the results of their work will find useful applications. This uncertainty is particularly characteristic of basic research that, by definition, is not motivated by

possible applications. Consequently, it is difficult to estimate the range of R&D activities that have an impact on the aerospace industry.

Federal Support of R&D Remains Critical to the Aerospace Industry

The federal government's support of R&D has been critical to maintaining the nation's global leadership in the aerospace industry. For example, government-supported research enabled the development of jet engine technologies that helped U.S. commercial and military aircraft manufacturers achieve global prominence. According to industry statistics, aerospace companies are funding an increasing portion of industrial R&D than they did in the past.[1] In fiscal year 2003, the most recent year for which data are available, federal funds supported 48 percent of industry R&D in the aerospace industry, whereas in 1999 the federal share was 63 percent. Nevertheless, the federal role remains significant.

Industrial R&D tends to focus on technology development that is specific to individual company products. As a result, company funding is significantly lower for basic and applied research than for development. According to aerospace industry statistics, federal dollars fund the majority of the basic and applied research performed by the aerospace industry, whereas most development is funded by companies themselves. In dollar terms, development expenditures, by both companies and the federal government, are much higher than research expenditures. Nonetheless, federal funds provide the dominant share of applied research support, in particular. Aerospace industry experts told us that, if industry is to benefit from federally funded basic and applied research, new technologies must be developed to a relatively high level to be easily applied to product development. Likewise, our prior work has found that technologies with a high level of maturity are more likely to be applied successfully to product development projects. An individual company is unlikely to invest its own money in basic and applied research that offers uncertain payoffs and might benefit competitors.

[1]For the purpose of this report, we define industry-funded R&D to exclude R&D funded by the government (and federally funded R&D centers) and academia.

Objectives of Federal Funding for Aerospace R&D Differ by Agency and Mission

R&D funding levels differ by agency and mission. The primary federal agencies engaged in aerospace R&D are Defense, NASA, and, to a lesser extent, FAA. Defense accounts for the majority of aerospace R&D funding.

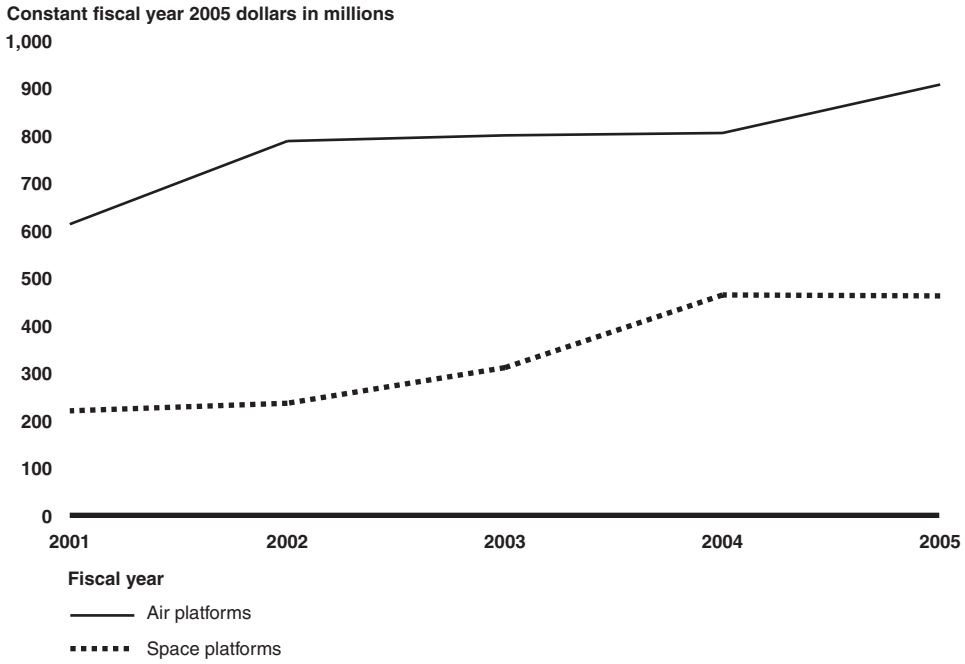
Department of Defense

Like Defense's budget in general, Defense's overall R&D budget has increased in recent years and is the largest federal supporter of R&D.[2] Its current modernization effort is driving increases in R&D expenditures for developing major weapons systems, including aviation, missile, and space systems. In 2005, with a budget of $8.1 billion, the ballistic missile defense program was the largest R&D program in Defense—nearly more than twice the budget of the Joint Strike Fighter, the second largest program. The Aeronautics and Space Report of the President estimates Defense's budget for space activities in fiscal year 2006 at $22.7 billion—over $7 billion more than NASA's. Within Defense's R&D budget are funds for science and technology activities. These fund R&D that is typically not associated with specific weapons systems and potentially can benefit a wide range of military and civilian applications.[3] Since 2001, Defense's science and technology budget has increased for both air and space activities (see fig. 7).

[2]For the purposes of this report, Defense's Research, Development, Testing and Evaluation budget is referred to as Defense's R&D budget.

[3]Defense's R&D budget is divided into seven categories in the Defense budget: basic research, applied research, advanced technology development, demonstration and validation, engineering and manufacturing development, management support, and operational systems development. The first three categories are referred to as science and technology.

Figure 7: Defense Budget for Science and Technology for Air and Space Platforms, Fiscal Years 2001-2005

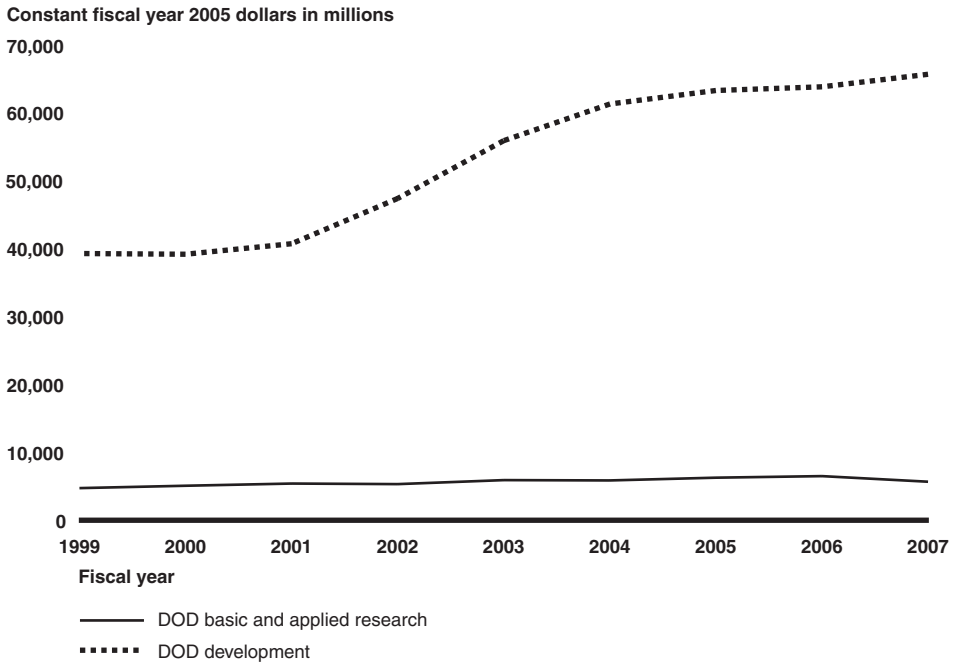


Source: GAO analysis of Defense data.

Note: Fiscal year 2005 is the latest year for which these data are available.

Like industry-funded R&D, defense R&D tends to focus on advanced stages of development rather on than basic or applied research. As a result, Defense's outlays for basic and applied research account for less than 10 percent, or $6.3 billion, of its total outlays for R&D in fiscal year 2005. Conversely, $63 billion went to development activities. For example, $8.2 billion of the Missile Defense Agency's $8.8 billion R&D budget for fiscal year 2005 went to development activities, not to basic or applied research. Nevertheless, Defense remains a significant supporter of basic and applied research, with Defense support climbing between fiscal years 2001 and 2006. (See fig. 8.) However, current plans call for a decline in fiscal year 2007.

Figure 8: Defense Budget Authority for Basic and Applied Research, and for Development, Fiscal Years 1999–2007



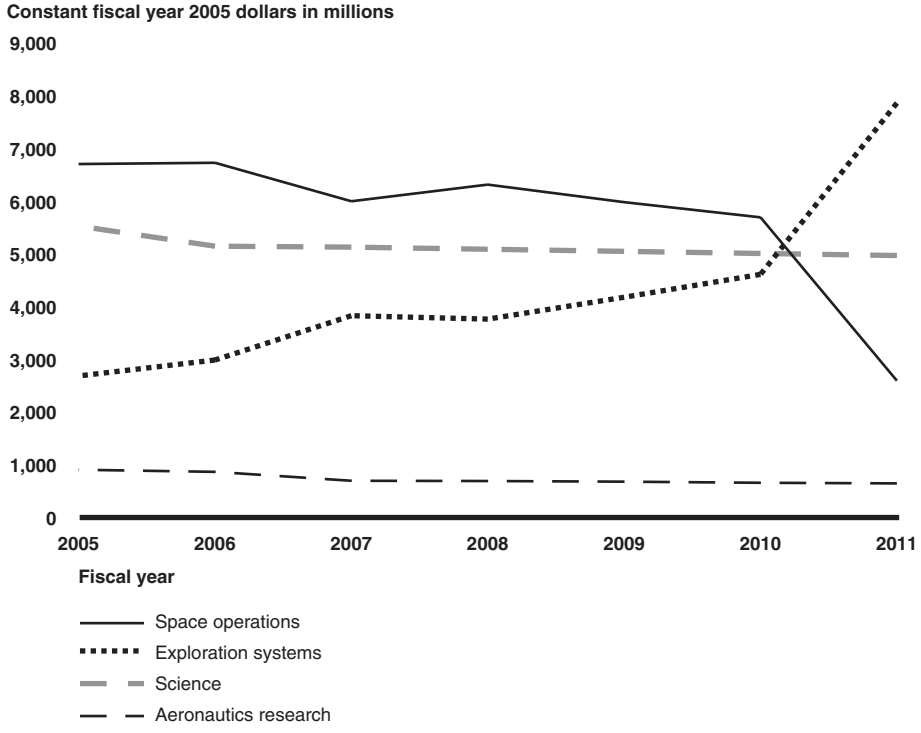
Source: GAO analysis of Defense budget documents.

Note: Defense funding data are not specific to aerospace activities. Fiscal year 2007 data come from the President's proposed budget; 2006 data are estimated outlays.

National Aeronautics and Space Administration

NASA's R&D includes a broad range of complex and technical activities—from space exploration to scientific observations of the solar system to the development of new aviation technologies, including those needed for NGATS. According to the President's proposed fiscal year 2007 budget and NASA's current plans, space exploration activities, including R&D, will continue to be the largest part of NASA's budget in the future. This trend will be driven by the development of a replacement vehicle for the space shuttle, manned lunar exploration, and robotic and manned Mars exploration missions. In contrast, funding for aeronautics research and some space and earth science research within NASA will decline until fiscal year 2011 (see fig. 9).

Figure 9: Actual and Projected Funding Trends in Major Aerospace-Related Missions within NASA, Fiscal Years 2005–2011



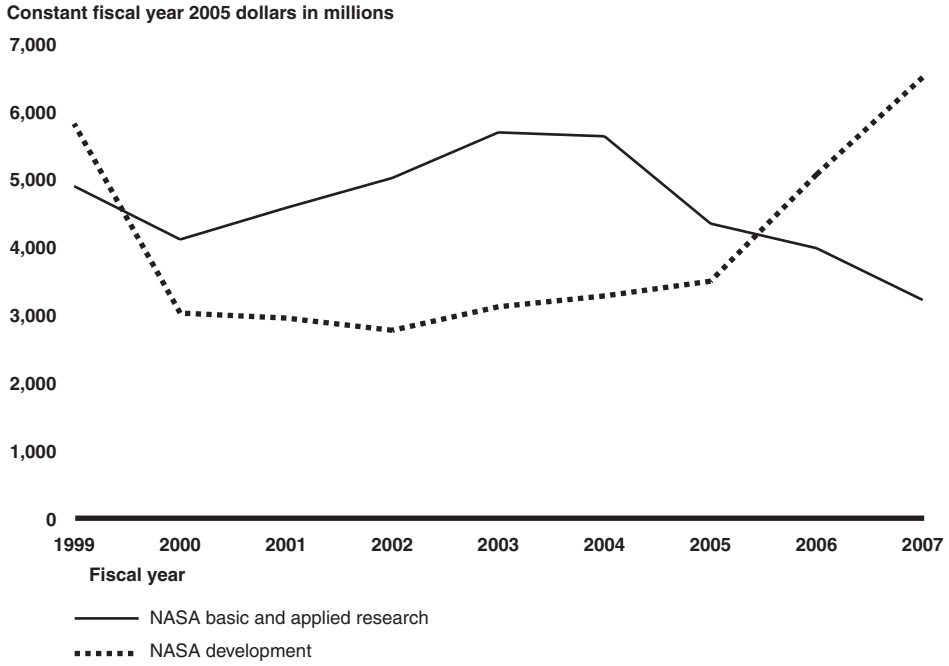
Source: GAO analysis of the President's fiscal year 2007 budget request for NASA.

Notes: Space operations includes the space shuttle, International Space Station, and flight support. Exploration systems includes the budgets for developing new space vehicles, such as the Crew Launch Vehicle and Crew Exploration Vehicle. Science includes earth-sun, solar system, and universe programs. Aeronautics research is the total budget for the Aeronautics Research Mission Directorate.

Fiscal year 2005 and fiscal year 2006 are actual funding amounts.

Like NASA's budget overall, the agency's R&D funding is relatively stable, but current space exploration plans call for a shift toward more development and less research. Consequently, NASA's funding for basic and applied research has been declining while its funding for development has increased (see fig. 10).

Figure 10: NASA's Budget Authority for Basic and Applied Research, and for Development, Fiscal Years 1999–2007



Source: GAO analysis of budget documents.

Federal Aviation Administration

The major focus of FAA's R&D is the realization of NGATS. The new system requires work in multiple areas, and several R&D programs are currently under way. However, FAA's R&D budget has generally declined since the publication of the Commission's report in 2002, because some programs have been completed and new NGATS projects have not taken their place (see fig. 11).[4] For example, R&D on Automatic Dependent

[4]FAA's R&D budget increased in fiscal year 2002 partly because of new post-September 11, 2001, aviation security funding. This security research is now funded through Homeland Security.

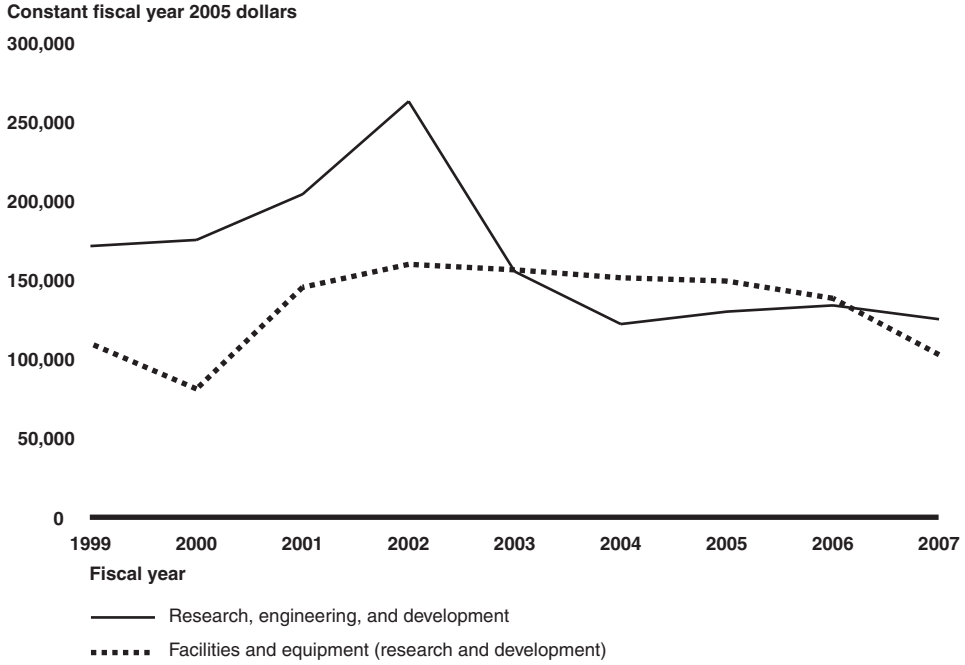
Surveillance Broadcast (ADS-B)[5] was completed in 2006, and no additional funding was sought for this program for fiscal year 2007. In addition, FAA's R&D budget includes projects that are not related to NGATS, such as aviation safety projects pertaining to weather and aircraft aging. FAA classifies a large proportion of its R&D as part of facilities and equipment activities.[6] This R&D includes a program to reduce runway incursions, the Capstone program[7] in Alaska, and several airspace programs, to name a few. Compared with Defense's and NASA's R&D activities, FAA's are small.

[5]ADS-B is a surveillance technology that transmits an aircraft's identity, position, velocity, and intent to other aircraft and to air traffic control systems on the ground, thereby enabling pilots and controllers to have a common picture of airspace and traffic.

[6]FAA's budget includes funds for 'Facilities and Equipment' activities. These activities aim to improve and modernize the equipment central to the national airspace system. Some of its facilities and equipment activities involve R&D.

[7]Capstone is an FAA program intended to improve aviation system safety in Alaska through the introduction of new navigation technologies.

Figure 11: FAA Outlays for R&D, Including R&D for Facilities and Equipment, Fiscal Years 1999–2007



Source: GAO analysis of FAA data.

Note: Facilities and equipment data include outlays for the airport improvement program and space commercialization R&D.

Appendix III: Federal Actions That Address Selected Aerospace Commission Recommendations

This appendix provides additional details on selected Commission recommendations and federal agency actions that address them. Included below are descriptions of the Commission's main recommendations and subrecommendations that we selected for review, as noted in appendix I. Also provided are descriptions of key federal agency actions, with time frames, that address both the main recommendations and the subrecommendations of the Commission report.

Recommendation: The Commission recommends the transformation of the U.S. air transportation system as a national priority. The transformation requires the:

- rapid deployment of a new, highly automated air traffic management system, beyond FAA's Operational Evolution Plan, robust enough to efficiently, safely, and securely accommodate an evolving variety and growing number of aerospace vehicles, and civil and military operations;
- accelerated introduction of new aerospace systems by shifting from product to process certification, and providing implementation support; and
- streamlined new airport and runway development.

Subrecommendation: The federal government should develop a federal interdepartmental group to work collaboratively with industry, labor, and other stakeholders, to plan a new, highly automated air traffic management system.

Federal Action:

- In December 2003 legislation, Congress directed DOT to create the Joint Planning and Development Office (JPDO) as an office within the FAA. The purpose of JPDO is to plan for the transition to NGATS and to coordinate aviation and aeronautics research programs across federal agencies. By January 2004, JPDO was established in FAA. Agencies participating in JPDO include the Departments of Commerce (Commerce) and Homeland Security (Homeland Security), DOT, FAA, NASA, Defense, and OSTP. The legislation also called for JPDO to consult with the public and ensure the participation of experts from the private sector.
- In December 2004, JPDO delivered to Congress the Integrated National Plan, which established a vision for the national air transportation system and a framework within JPDO for accomplishing that vision. The plan also

established multi-agency integrated product teams responsible for each of eight strategies—airport infrastructure, security, an agile air traffic system, shared situational awareness, safety management, environment, weather, and global harmonization. In addition, a JPDO Senior Policy Committee made up of executive-level individuals from all partner agencies was established to provide high-level guidance, resolve major policy issues, and identify resource needs.

- Resources provided to JPDO by FAA and NASA:

  FAA

  - FAA provided $18 million in fiscal year 2006 to support JPDO and will provide a similar amount of funds in fiscal year 2007.
  - FAA leads four of JPDO's integrated product teams and provides approximately 90 employees to support JPDO and the product teams.
  - In the President's 2007 budget submission, DOT requested $80 million for Automated Dependent Surveillance Broadcast (ADS-B), which is a surveillance technology that transmits an aircraft's identity, position, velocity, and intent to other aircraft and to air traffic control systems on the ground, thereby enabling pilots and controllers to have a common picture of airspace and traffic. DOT also requested $24 million for the System Wide Information Network, which would support the transition to network-centric operations by providing the infrastructure and associated policies and standards to enable information sharing among all authorized users, such as the airlines, other government agencies, and the military.

  NASA

  - NASA provided $18 million in fiscal year 2006 to support JPDO and will provide a similar amount of funds in fiscal year 2007.
  - NASA's fiscal year 2006 NGATS contributions total $174 million (for Airspace Systems research). NASA requests for future NGATS air traffic management research funding are:
    - Fiscal year 2007: $120 million
    - Fiscal year 2008: $124 million
    - Fiscal year 2009: $105 million
    - Fiscal year 2010: $91 million

- NASA's Aviation Safety Program and Subsonic Fixed Wing project also contribute to NGATS research. This program and this project also provide benefits to other federal agencies and private industry beyond specific NGATS research needs.

Subrecommendation: The federal government should develop initial implementation efforts that should focus on changing those federal policies and procedures, such as navigation and surveillance systems, that will provide early and significant operational benefits with little or no added "out-of-pocket" investments.

Federal Action:

- In 2002, FAA committed to develop and implement a plan for performance-based navigation, which uses two concepts—"Area Navigation," commonly known as RNAV, and required navigation performance (RNP) operations. RNAV allows operators of properly equipped aircraft to use onboard navigation capabilities to fly desired flight paths without requiring direct flight over ground-based navigation aids. RNP adds to RNAV by taking advantage of the aircraft's avionics navigation performance-monitoring and alerting capability. By potentially allowing users to fly shorter routes, RNAV and RNP hold promise to reduce flight times and fuel consumption; this would, in turn, save system users time and money. In addition, RNP could potentially increase the capacity of the air traffic control system to handle air traffic by reducing the required distance (i.e., separation) between aircraft equipped with advanced navigation capabilities.

- FAA published a plan in 2003 (updated in July 2006) that lays out milestones for RNAV and RNP implementation over three planning horizons: near-term (2006–2010), mid-term (2011–2015), and far-term (2016–2025). For example, a near-term milestone is to develop 25 RNP approaches per year over the next 5 years.

- In June 2005, FAA published criteria for use in designing public RNP instrument approach procedures and, as of August 2006, FAA runs RNP procedures in Washington, D.C. (Reagan National Airport); San Francisco, California; Portland, Oregon; Palm Springs, California; and Juneau, and six smaller city airports, in Alaska. FAA has also published standard RNP procedures for Hailey (Sun Valley), Idaho; Newark, New Jersey; Chicago (Midway), Illinois; Long Beach, California; Tucson, Arizona; and Gary, Indiana, and expects to be using the new published RNP procedures at these six additional airports later this year, as more aircraft operators become approved for RNP approaches.

- FAA has installed and tested ADS-B technology on a limited basis in aircraft since 2000 in a demonstration program in Alaska called Capstone, which is a program intended to improve aviation system safety in Alaska through the introduction of new navigation technologies. In addition, FAA has been running ADS-B procedures in the Gulf of Mexico, and at airports in Louisville, Kentucky, and Memphis, Tennessee.

- In September 2005, FAA executives reviewed information on investment and alternatives for the ADS-B program and approved the technology for a more thorough analysis for possible future deployment on a national basis. In the first half of 2006, FAA will analyze specific costs and benefits for implementing the technology and submit a final proposal for FAA executive-level review in June 2006. With a positive investment decision, the first ADS-B implementation segment envisions the potential deployment of approximately 400 ground-based transmitters and the implementation of terminal, en route, and broadcast ADS-B services from fiscal years 2007–2012.

Figure 12: Global Positioning System Display Screen Used in Capstone Program

Source: Garmin, Ltd.

Sub-recommendation: FAA should support and motivate efforts for the installation of system-critical airborne equipment by providing either full

or partial federal funding, or by auctioning investment credits, for such equipment.

Federal Action:

- In 1999, the Capstone program received initial funding. This first phase focused on providing advanced navigation capability and equipment for aircraft operating air taxi services in southwest Alaska. By 2004, FAA had installed 11 ground-based navigation transmitters and equipped 208 aircraft with Capstone avionics capabilities, such as ADS-B. The Capstone program includes full funding for operator equipage.

- In 2003, Capstone phase II expanded the program to air taxi aircraft in southeast Alaska and included similar navigation capabilities and full funding for operator equipage. As of June 2006, the FAA has a total of 366 aircraft in the Capstone program.

- A September 2004 plan for phase III of Capstone calls for expanding Capstone throughout Alaska. The plan proposed $25 million per year through fiscal year 2007 for reimbursements to pilots who paid for Capstone equipment and installation. A final decision on Capstone phase III is expected by the end of summer 2006.

Sub-recommendation: The federal government should streamline the regulatory process to enable timely development of regulations needed to address new technologies.

Federal Action:

- FAA uses several approaches to streamline the regulatory process for new technologies:

  - FAA sometimes uses a "special condition" to approve new technology under an existing rule. For example, FAA issued a new standard on the existing type of certificate for a general aviation aircraft to allow a parachute to be deployed as a last resort in an emergency. The parachute recovery system is intended to prevent serious passenger injuries by parachuting the aircraft to the ground.

  - FAA sometimes uses existing regulations without a special condition and publishes new methods of compliance for the new technology. The methods are neither mandatory nor regulatory but describe acceptable means for showing compliance with regulations. For example, in December 2005, FAA published an advisory circular on the acceptable

means for showing compliance for the use of "synthetic vision" developed by the military.

- FAA has also developed new procedures that apply to all rule making, including rules for new technologies. Highlights include the following:

  - In 2003, FAA supplemented its weekly management review of ongoing rule making with a standing meeting of senior policy makers to review significant rules in order to expedite their review. It also gave a higher priority to nonsignificant rules that had gone through the public comment stage.

  - In 2004, to link rule-making performance with pay, FAA created shared executive compensation incentives for senior executives that are tied to timely completion of rules.

  - In 2005, FAA adopted a performance standard that requires 80 percent of all initiated rules to be issued within 90 days of their originally scheduled issuance date.

Subrecommendation: FAA should focus on certifying a manufacturing organization's internal design, simulation, testing, and quality assurance processes to ensure that organizations' products comply with all applicable regulations, and are delivered in a condition for safe operation.

Federal Action:

- In October 2005, FAA issued a final rule for a new Organization Designation Authorization. This program expands the number of organizational designees and should ultimately reduce the number of individual designees. FAA's designee programs authorize about 13,400 private individuals and about 180 organizations nationwide, known as "designees," to act as representatives of the agency to conduct many safety certification activities, such as administering flight tests to pilots, inspecting repair work by maintenance facilities, conducting medical examinations of pilots, and approving designs for aircraft parts. The program allows FAA to expand and standardize the approval functions of organizational designees and also expand eligibility for organizational designees. FAA issued a final order for the rule in 2006.

- In addition, Congress has mandated that FAA develop and implement a certified design organization program. Under this program, certain designees that design and produce aircraft parts and equipment would no longer be designees; rather, they would conduct their approval functions

under a newly created FAA certificate. FAA expects to provide a report to Congress, by the mandated December 2007 deadline, for the development and oversight of a system to certify design organizations.

Subrecommendation: FAA and other agencies should adopt regulations or procedures that would expedite new runway and airport development.

Federal Action:

- FAA is reallocating staff resources and increasing the use of consultants to assist it with the coordination and administration of environmental impact statements.

- To increase coordination and reduce delays, FAA has created a process for establishing multidisciplinary environmental review teams for new reviews at large hub airports.

- In April 2006, FAA completed a revised order for streamlining airport development projects that includes the ability to give priority review to certain projects; promotes public review and comment; manages timelines during the review; and expedites coordination between those federal, state, and local agencies involved in environmental reviews in order to reduce undue delays during the review process.

- To increase coordination and assign accountability for new runway construction tasks, FAA is using detailed plans called Runway Template Action Plans to provide a standard set of tasks that must be considered when developing new runways (FAA developed the tool in August 2001).

Recommendation: The Commission recommends that the United States create a space imperative. Defense, NASA, and industry must partner in innovative aerospace technologies, especially in areas of propulsion and power. These innovations will enhance national security, provide major spin-offs to the economy, accelerate the exploration of the near and distant universe with both human and robotic missions, and open up new opportunities for public space travel and commercial space endeavors in the twenty-first century.

Subrecommendation: Explore and exploit space to ensure national and planetary security, economic benefit, and scientific discovery.

Federal Action:

- In January 2004, Executive Order 13326 established the President's Commission on Implementation of United States Space Exploration Policy. This commission was chartered to provide recommendations to the President on implementing the vision outlined in the President's policy statement entitled "A Renewed Spirit of Discovery," and the President's budget submission for fiscal year 2005. The commission published its report in June 2004.

- In 2004, NASA formed the Exploration Systems Mission Directorate to implement the President's vision. Throughout 2005, the directorate restructured its organization by reducing headquarters staff, designating program and project offices at NASA centers, and realigning activities to other mission directorates.

- Defense published its space science and technology strategy in 2004. This strategy, which provides guidance for Defense space science and technology activities, is derived jointly from the Defense Science and Technology Strategy and the National Security Space Strategy. The strategy addresses space science and technology development, outlines strategy implementation, describes the process by which space science and technology progress is assessed, and identifies the means by which these goals can be achieved.

- In August 2005, Defense and NASA signed an agreement on how they could coordinate their efforts to implement NASA's space transportation strategy. The agreement focused on the use and development of national launch systems.

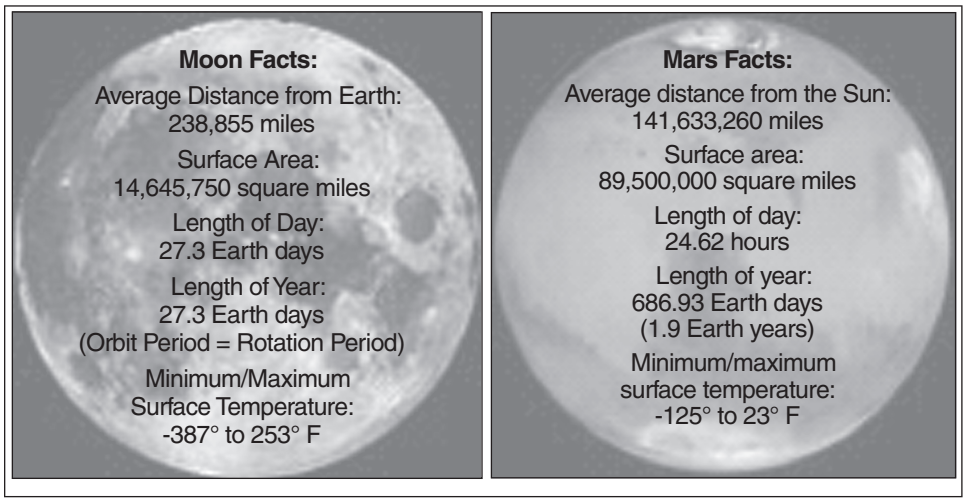
- In November 2005, to assist in implementing the President's space exploration policy, NASA published its Exploration Systems Architecture Study. The purpose of the study was to

    - assess the top-level crew exploration vehicle requirements,
    - define the top-level requirements and configurations for crew and cargo launch systems to support the lunar and Mars exploration programs,
    - develop a reference exploration architecture concept to support sustained human and robotic lunar exploration operations, and
    - identify key technologies required to enable and significantly enhance these reference exploration systems, and reprioritize near-term and far-term technology investments.

- On the basis of analysis and recommendations, NASA realigned research and technology projects. As a result, some programs were curtailed, modified, deferred, or added.

- NASA and DOD established the Partnership Council to provide a forum for senior Defense and civil space leaders to meet on a regular basis to discuss cross-cutting issues relevant to the national space community. The purpose of the Partnership Council is to facilitate communication between the organizations and to identify areas for collaboration and cooperation.

Figure 13: Information Regarding the Moon and Mars



Source: NASA.

Subrecommendation: The federal government should support the development of commercial space operations, such as space tourism.

Federal Action:

- FAA's Office of Commercial Space Transportation regulates the U.S. commercial space transportation industry by licensing commercial space launches and nonfederal spaceports. Commercial space operations have historically launched commercial or government payloads (generally satellites) into orbit from Air Force launch sites. The industry is changing with the development of commercial vehicles that enable human space flight from nonfederal spaceports. FAA is developing regulations for launch vehicles and spaceports. The proposed regulations, based on common safety standards developed jointly by FAA and the Air Force,

have the goal of promoting consistent, streamlined safety reviews of launch and reentry operations at all launch sites.

- The Commercial Space Launch Amendments Act of 2004 prohibits FAA from regulating crew and passenger safety before 2012 in order to encourage growth in the emerging space tourism industry.

Figure 14: Proposed Advanced Orbital Transfer Propulsion Technology

Source: NASA.

Recommendation: The Commission recommends that the federal government establish a national aerospace policy and promote aerospace by creating a government-wide management structure. This would include a White House policy coordinating council, an aerospace management office in the Office of Management and Budget, and a joint committee in Congress. The Commission further recommends the use of an annual aerospace sector budget to establish presidential aerospace initiatives, ensure coordinated funding for such initiatives, and replace vertical

decision making with horizontally determined decisions in both authorizations and appropriations.

Subrecommendation: Develop a process to bring the appropriate departments and agencies together to reach a consensus on a national aerospace policy.

Federal Action:

- In January 2004, the President announced the Vision for Space Exploration, which serves as the nation's space exploration policy. This policy directs NASA to advance U.S. scientific, security, and economic interests through a space exploration program.

- In December 2004, the administration approved the U.S. Space Transportation Policy. This policy's goal was to ensure the capability to access and use space. It sets out implementation guidelines and actions for federal departments and agencies, including NASA, Defense, and DOT.

- In September 2005, the National Science and Technology Council established the Aeronautics, Science, and Technology Subcommittee (ASTS). (See fig. 15.) The objective of ASTS is to develop a national aeronautics R&D policy. This policy is expected to establish a set of specific U.S. aeronautics research objectives; define the appropriate role of the federal government in aeronautics R&D; define the roles and responsibilities of the various departments and agencies in aeronautics R&D; address the research, development, test, and evaluation infrastructure; and address the coordination of aeronautics research across the federal government.

    - In April 2006, ASTS convened three stakeholder meetings to discuss aeronautics R&D priorities, the appropriate role of the federal government, near- and far-term research objectives and a plan to achieve them, and the roles and responsibilities of the multiple federal agencies involved in aeronautics research. Representatives from government, industry, the aviation user community, and academia participated.

    - ASTS is co-chaired by OSTP and NASA, and includes the Department of Energy, Commerce, Defense, Homeland Security, DOT, FAA, JPDO, the National Science Foundation, the Council of Economic Advisors, the Domestic Policy Council, the U.S. Trade Representative, U.S. International Trade Commission, the Office of the Vice President, the National Security Council, and the Office of Management and Budget.

ASTS is working on renewing its charter, which will expire on December 31, 2006. The renewed charter would expire on March 31, 2009.

- In December 2005, Congress directed OSTP to commission an independent review of the nation's long-term strategic needs for aeronautics test facilities. Congress also required OSTP to conduct a study to determine (1) if any NASA R&D programs are unnecessarily duplicating aspects of programs of other federal agencies; and (2) if any such programs are neglecting any topics of national interest that are related to NASA's mission.

Figure 15: ASTS Membership

Sources: Corel Draw; GAO.

Subrecommendation: Establish an office of aerospace development in each federal department and agency, and have a full-time senior executive lead the office and report directly to the office of the secretary, or the agency head.

Federal Action:

- No action taken.

Subrecommendation: Congress should establish a Congressional Joint Committee on Aerospace that would have the obligation to legislatively coordinate the multifaceted jurisdiction issues.

Federal Action:

- No action taken.

Subrecommendation: Establish an Aerospace Policy Coordinating Council to develop and implement an integrated means of formulating a national aerospace policy.

Federal Action:

- As of January 2006, no single national aerospace policy existed. There are two policy efforts in place to address space and aeronautics issues separately.

- The National Security Council has drafted space policies that address the major space sectors such as position, navigation, and timing; commercial remote sensing; and space transportation.

- OSTP and NASA are co-chairing the Aeronautics Subcommittee of the National Science and Technology Council to coordinate U.S. aeronautics research and development activities.

Subrecommendation: Have the Office of Management and Budget assume a new and proactive role as coordinator of federal agencies' aerospace-sector plans, programs, and budgets.

Federal Action:

- No action taken.

Recommendation: The Commission recommends that U.S. and multilateral regulations and policies be reformed to enable the movement of products and capital across international borders on a fully competitive basis, establishing a level playing field for U.S. industry in the global marketplace. This includes substantially overhauling U.S. export control regulations. The Commission also recommends that the U.S. government neutralize foreign-government market intervention in areas such as

subsidies, tax policy, export financing, and standards—either through strengthening multilateral disciplines or providing similar support for U.S. industry as necessary.

Subrecommendation: The U.S. government should reform the nation's arms transfer policy and regulatory process.

Federal Action:

- In February 2002, Congress had two bills before it —H.R. 2581 and S. 149—that proposed a new legal basis for controls over exports of dual-use goods and services. Neither bill was passed.

- H.R. 4572 was introduced on December 16, 2005. This bill, which sought to extend the Export Administration Act, among other items, would have revised this act, especially in the areas of penalties, enforcement, and U.S. policy towards multilateral export control regimes. No action has been taken on this bill as of September 2006.

Subrecommendation: The U.S. government should overhaul current export-control restrictions on the sale or transfer of technology to foreign customers by implementing a fundamental shift—from the existing transaction-based licensing system to process licensing.

Federal Action:

- In 2001, the Department of State (State) and Defense established an "expedited" process for reviewing license applications in support of Operation Enduring Freedom and Operation Iraqi Freedom.

- In 2000, State announced the Defense Trade Security Initiative, which was characterized as the first major post-Cold War adjustment to the arms export control system and an effort to facilitate defense trade with allies. As part of this effort, State established special processes for the expedited review of license applications determined to be in support of the North Atlantic Treaty Organization's Defense Capabilities Initiative. In addition, State developed the D-Trade system, which came on line in January 2004. This is a Web-based license application submission and review system that allows companies to electronically submit export authorization requests and supporting documentation for review.

Subrecommendation: The U.S. government should ensure commitment to global partnerships in air transportation systems and space activities by

supporting the recruitment of FAA employees for the International Civil Aviation Organization (ICAO).

Federal Action:

- FAA established a Web site to increase employees' awareness of ICAO positions.
- FAA tracks ICAO vacancies and solicits qualified candidates to fill the U.S. positions.
- In 2003, FAA established the FAA/ICAO fellowship program, which sends FAA employees to work at ICAO for up to 12 months.
- Senior FAA officials give speeches and presentations at FAA organizations such as the Hispanic Coalition and the Professional Women's Air Traffic Control Organization.

Subrecommendation: The U.S. government should ensure commitment to global partnerships in air transportation systems and space activities by working for continued liberalization of the air transport market.

Federal Action:

- As of July 2006, the United States had 76 "open skies" agreements with foreign governments. "Open skies" agreements are bilateral agreements between two nations that reduce or eliminate operating restrictions on the airlines of either nation.

Recommendation: The Commission recommends that the nation immediately reverse the decline in, and promote the growth of, a scientifically and technologically trained U.S. aerospace workforce. In addition, the nation must address the failure of the math, science, and technology education of Americans. The breakdown of America's intellectual and industrial capacity is a threat to national security and its capability to continue as a world leader. Congress and the administration must therefore do the following:

- Create an interagency task force that develops a national strategy on the aerospace workforce to attract public attention to the importance of, and opportunities within, the aerospace industry.

- Establish lifelong learning and individualized instruction as key elements of educational reform.

- Make long-term investments in education and training with a major emphasis in math and science so that the aerospace industry has access to a scientifically and technologically trained workforce.

  Subrecommendation: Establish an interagency task force on workforce issues in the aerospace industry.

  Federal Action:

- In 2004, Labor established an interagency taskforce that included the Department of Education, Commerce, Defense, DOT, NASA, OSTP, the National Science Foundation, and the Office of Management and Budget.

- Labor hosted the Aerospace Workforce Forum in June 2004. This forum included stakeholders representing industry, education, and government agencies with the objective of involving the public in developing solutions that address the decline in the U.S. technical workforce. The forum developed multiple recommendations to address the overall workforce issues. These recommendations focused on the aging workforce and the loss of technical talent.

- In 2005, the House passed H.R. 758, a bill that will require federal agencies to establish an interagency aerospace revitalization task force to develop a national strategy for aerospace workforce recruitment, training, and cultivation. The bill proposes that the task force meet at least twice a year and produce an annual report no later than 1 year after the date of the act's enactment, and annually thereafter for 4 years. As of September 2006, no action has been taken on this bill in the Senate.

  Subrecommendation: Develop a national strategy to attract public attention to the importance of, and opportunities within, the aerospace industry.

  Federal Action:

- In collaboration with the private sector, educational institutions, and local employment agencies, Labor issued a 2005 report on workforce challenges facing the aerospace industry and possible solutions to these challenges.

- The President's High Growth Job Training Initiative targets 14 industries, including aerospace, that have been identified as important to the U.S. workforce.

- H.R. 758, described previously in this appendix, would also require federal agencies to develop a national strategy for aerospace workforce development.

Subrecommendation: Develop workforce skills needed by the industry and promote registered apprenticeship programs for technical and skilled occupations.

Federal Action:

- Since 1991, FAA has sponsored the Aviation and Space Education Outreach Program, which teaches students between kindergarten and the 12th grade about aerospace technology and career opportunities.

- Since 2001, under the President's High Growth Job Training Initiative, Labor has issued eight aerospace industry demonstration grants, totaling over $10 million. These grants funded demonstration projects to help train and improve the U.S. aerospace workforce.

- In December 2003, Congress enacted Vision 100—Century of Aviation Reauthorization Act (Vision 100),[1] which included language to promote the aerospace workforce and to fund a scholarship program for careers in aerospace-related fields.

- In the NASA Authorization Act of 2005, Congress directed NASA to develop a human capital strategy to ensure that NASA has a workforce of the appropriate size and with the appropriate skills to carry out its programs. NASA has assigned a team of representatives from each of its centers and directorate locations to coordinate and identify the skills available at these locations. The results of this process are scheduled for completion by the end of fiscal year 2006.

- In February 2006, Labor announced a series of grant awards under the Workforce Innovation in Regional Economic Development Initiative. Over three years, this initiative will provide $195 million to thirteen regions to

[1]Pub.L. No. 108-176 (Dec. 12, 2003).

address the skill challenges of one or more industries, including aerospace, which has been identified as critical for economic growth.

- In April 2006, the Subcommittee on Technology, Innovation, and Competitiveness of the Senate Committee on Commerce, Science, and Transportation held a hearing to examine approaches for fostering innovation in math and science.

Subrecommendation: Make tax credits available to employers who invest in the skills and training programs needed by the industry.

Federal Action:

- No specific tax credit is available to the aerospace industry.

- In 2006, the President proposed making an R&D tax credit permanent to encourage private-sector investment in technology. For fiscal year 2007, the administration budgeted $4.6 billion for the R&D incentives.

Subrecommendation: Make long-term investments in education and training with a major emphasis in math and science, so that the aerospace industry has access to a scientifically and technologically trained workforce.

Federal Action:

- In 2002, NASA unified all of its educational programs (previously managed by individual mission offices and field centers) under one organization and vision.

- NASA's five programs target elementary and secondary education, higher education, NASA exhibits and community-based events, and the Minority University Research and Education Program. Funding for NASA's education programs has decreased from $217 million in fiscal year 2005 to about $153 million in the fiscal year 2007 budget. This budget decrease, for example, will result in NASA deferring the implementation of the Science and Technology Scholarship Program.

- In 2005, Congress directed NASA to review its educational programs. This review will be conducted by the National Research Council of the National Academy of Sciences and will evaluate NASA's precollege science, technology, and mathematics education programs.

- Congress established Defense's scholarship program ("SMART") for students in science and math under the National Defense Authorization Act for fiscal year 2005. These scholarships and fellowships are awarded to applicants who are pursuing a degree in, or closely related to, science, mathematics, or engineering.

- In 2006, the President announced the American Competitiveness Initiative to encourage innovation in science and technology, and to support math and science education. In the fiscal year 2007 budget, the administration has committed $5.9 billion for R&D, education, and entrepreneurship. Over the next 10 years, the administration plans to commit $50 billion to increase funding for research and $86 billion for R&D tax incentives.

- In 2006, the President proposed a plan to train an additional 70,000 high school math and science teachers with the objective of increasing advanced-placement courses in math and science. In addition, up to 30,000 math and science professionals will be recruited to teach in classrooms nationwide.

Recommendation: The Commission recommends that the federal government significantly increase its investment in basic aerospace research, which enhances U.S. national security; enables breakthrough capabilities; and fosters an efficient, secure, and safe aerospace transportation system. The U.S. aerospace industry should take a leading role in applying research to product development.

Subrecommendation: Increase and provide stable funding in order to achieve national technology goals, especially in long-term research in areas such as propulsion and power, emissions and noise, and human factors; as well as associated research, development, testing, and equipment infrastructure.

Federal Actions:

- FAA's R&D funding declined from $349 million in fiscal year 2001 to $279 million in fiscal year 2005 (in constant fiscal year 2005 dollars). FAA plans indicated that these funds support the R&D needs of NGATS.

- Defense's R&D funding has increased overall since the publication of the Commission report. The majority of the department's R&D funding goes to development activities, but Defense's science and technology budgets for air and space research have increased between fiscal years 2001 to 2005 from $613 million and $220 million to $907 million and $462 million, respectively (in fiscal year 2005 dollars).

- NASA's overall R&D budget has decreased slightly, shifting from $10.6 billion in fiscal year 2001 to $10.2 billion in fiscal year 2005 (in constant fiscal year 2005 dollars). Looking forward, NASA's budget is expected to vary between missions. Space activities are expected to increase overall, though some programs will decline, whereas aeronautics research is expected to decline. For example, NASA's fiscal year 2007 budget request for the Exploration Systems Mission Directorate increased by $1.3 billion over 2006 levels to nearly $3.1 billion (a 76 percent increase), but the Aeronautics Research Mission Directorate request is about $724 million for 2007—down 18 percent from the fiscal year 2006 budget in non-inflation-adjusted dollars.

- NASA's reshaped aeronautics research strategy will focus on four programs, including one that targets air traffic management research for NGATS.

- In June 2006, the National Academy of Sciences issued a study on NASA's long-term strategy for aeronautics research and technology development. It identifies four high-priority strategic objectives for civil aeronautics research and, among its recommendations, suggests that NASA establish a stable aeronautics research plan, balance in-house research with involvement from academia and industry, and ensure technologies are developed to a level of maturity that is appropriate for that technology.

Figure 16: Engineers at NASA Langley Research Center

Source: NASA.

Subrecommendation: Adopt national technology demonstration goals for 2010 on air transportation and space.

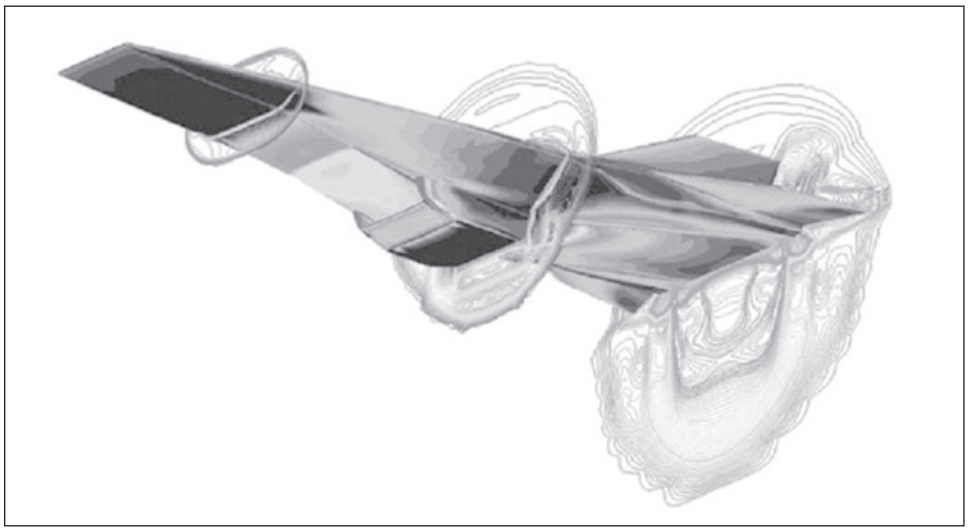
Federal Action:

- JPDO identified technology goals in its NGATS plan. These goals are not consistent with the goals outlined in the Commission's report. For example, the NGATS plan calls for a 30 percent reduction in transit time for domestic aviation travel, whereas the Commission calls for a 50 percent reduction in travel time between any two points on earth, as well as between any two points in space. In general, the Commission's goals are more specific and aggressive than the NGATS goals.

- In 2006, NASA's Aeronautics Research Mission Directorate announced plans for R&D. These plans do not include demonstration goals. In addition, NASA cancelled funding in fiscal year 2004 for the Hyper-X

hypersonic vehicle program, which demonstrated air-breathing flight of mach 9.6 in 2004.

Figure 17: Computational Fluid Dynamic Image of the Hyper-X Vehicle



Source: NASA.

Subrecommendation: Find new and faster ways to transfer research and technology developed in federal laboratories, and in academia, to applications in the private sector, by establishing partnerships between government, industry, and academia.

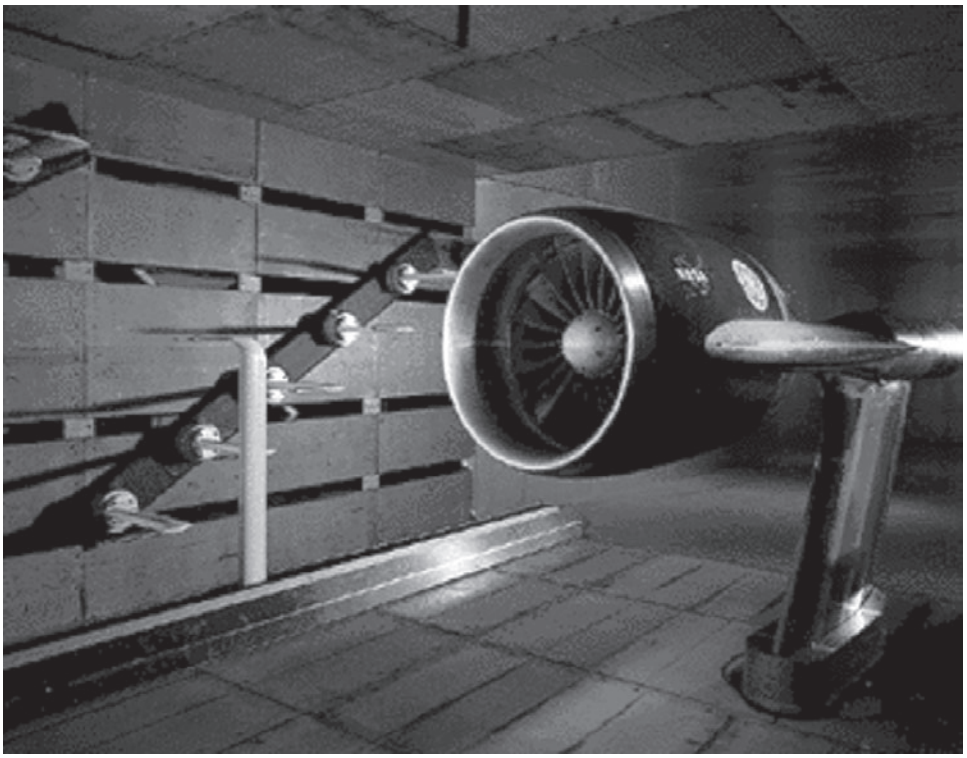
Federal Action:

- NASA's research strategy includes a new approach for establishing partnerships with universities and the private sector. Some key milestones in this approach include the following:
  - In January 2006, NASA issued three requests for information that will be used to solicit information on key areas of interest for private industry and determine opportunities for collaboration with NASA's planning and research efforts.
  - In May 2006, NASA released research announcements to solicit proposals for foundational research in areas where NASA needs to enhance its core capabilities. The announcements were influenced by the response to the requests for information, solicited in January 2006, and were open to all stakeholders.

- NASA's realigned aeronautics research mission plans to focus on foundational research and will develop new technologies to a lower—and therefore less readily adopted—maturity level than in the past.

- In 2004, NASA's Centennial Challenges Program initiated competitions, with prizes under $250,000, for advances in a variety of technical areas such as astronaut gloves, high strength-to-weight materials, and telerobotic construction. The 2005 NASA Authorization Act provided NASA with the legislative authority to conduct competitions with prizes up to $1,000,000.

Figure 18: NASA Glen Research Center's Research on Aircraft Noise



Source: NASA.

Appendix IV: Joint Planning and Development Office

Role of the Joint Planning and Development Office in the National Airspace System Modernization

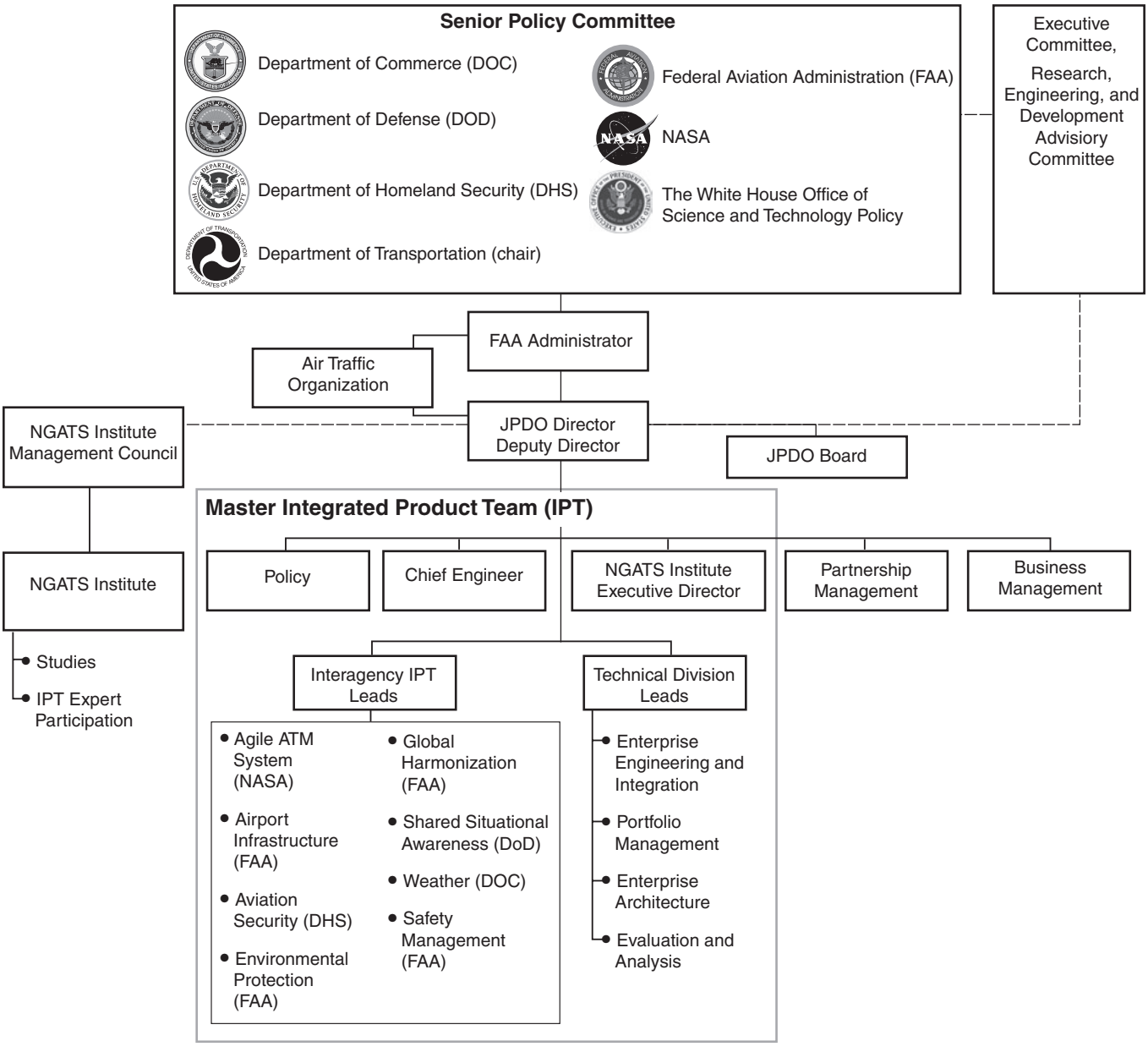
FAA, with research assistance from NASA, has had the primary responsibility for planning and implementing national airspace system modernization since these efforts began more than 20 years ago. Recently, FAA placed the modernization program under a new Air Traffic Organization (ATO), headed by a Chief Operating Officer. The JPDO Director reports to the FAA Administrator and to ATO's Chief Operating Officer.[1] JPDO's scope is broader than traditional air traffic control modernization in that it is "airport curb-to-airport curb," encompassing such issues as security screening and environmental concerns. Additionally, JPDO's approach will require unprecedented consensus and cooperation among many stakeholders—federal and nonfederal—about necessary system capabilities, equipment, procedures, and regulations.

[1]ATO is FAA's business unit that is responsible for operating, maintaining, and modernizing the nation's current air traffic control system.

JPDO Organization Structure and Partner Agencies

JPDO was mandated by the Vision 100 and is comprised of seven partner agencies: Commerce, Homeland Security, DOT, Defense, FAA, NASA, and OSTP. Each of these agencies has expertise and technology that will play a part in creating NGATS and responsibilities for coordinating their activities. Figure 19 lists JPDO's organization and how its partner agencies fit into that organization. JPDO has staffed its organization with partner-agency employees, many of whom work for JPDO on a part-time basis. The JPDO board, which provides coordination between partner agencies and JPDO, is composed of key executives of the partner agencies who can facilitate bringing agency resources to bear on NGATS development. Additionally, Vision 100 created the Next Generation Air Transportation Senior Policy Committee, composed of partner agency senior executives, to provide ongoing policy review and identify resource needs from the partner agencies.

Figure 19: JPDO Organization Chart



Source: JPDO.

JPDO's Integrated Plan

In December 2004, JPDO and its partner agencies developed and submitted to Congress its integrated plan that broadly addresses the goals and objectives for NGATS. This plan provided a vision statement that elaborates on the broadly stated common outcome set forth by the Vision 100 legislation—an air transportation system that meets potential air traffic demand by 2025. In addition, the plan provides eight strategies that formed the basis for JPDO's eight integrated product teams, and various partner agencies have taken the lead on specific strategies. (See table 5.) In March 2006, JPDO published its first report to Congress on the progress made in carrying out the integrated plan.

Table 5: JPDO's Strategies and Responsible Agencies

Strategy	Lead agency
Develop airport infrastructure to meet future demand	FAA
Establish an effective security system without limiting mobility or civil liberties	Homeland Security
Conduct research to enable an agile air traffic system that quickly responds to shifts in demand	NASA
Establish shared situational awareness—where all users share the same information	Defense
Establish a comprehensive and proactive approach to safety	FAA
Develop environmental protection that allows sustained aviation growth	FAA
Develop a systemwide capability to reduce weather impacts	Commerce
Harmonize equipage and operations globally	FAA

Source: GAO presentation of JPDO data.

JPDO Efforts to Leverage Partner Agency Resources

Vision 100 requires JPDO to coordinate NGATS-related programs across the partner agencies. To address this requirement, JPDO conducted an initial interagency review of its partner agencies' R&D programs during July 2005 to identify work that could support NGATS. Through this process, JPDO identified early opportunities that could be pursued during fiscal year 2007 to coordinate and minimize the duplication of research programs across the partner agencies and produce tangible results for NGATS. In addition, JPDO is currently working with the Office of Management and Budget to develop a systematic means of reviewing the partner agencies' budget requests, so that the NGATS-related funding in each request can easily be identified. Such a process would help the Office of Management and Budget consider NGATS as a unified federal investment, rather then as disparate line items distributed across several agencies' budget requests.

The challenge of leveraging resources will likely intensify beginning in 2008, when JPDO expects a significant increase in the workload of its integrated product teams. JPDO anticipates needing more resources for the teams to, among other things, plan demonstrations of potential technologies to illustrate some of the early benefits that could be achieved from the transformation to NGATS.

JPDO Is Involving Nonfederal Stakeholders

JPDO has structured itself in a way that involves federal and nonfederal stakeholders throughout its organization. Vision 100 directed JPDO to involve nonfederal stakeholders as it fulfills its mission. Nonfederal stakeholders may participate through the NGATS Institute. Through this institute, JPDO obtained the participation of over 180 stakeholders from over 70 organizations for the integrated product teams. The NGATS Institute Management Council, composed of top officials and representatives from the aviation community, oversees the policy and recommendations of the institute and provides a means for advancing consensus positions on critical NGATS issues.

As with its federal partner agencies, JPDO has no direct authority over the human, technical, or financial resources of its nonfederal stakeholders. To date, nonfederal stakeholders spend approximately 10–25 percent of their time, per week, on the integrated project teams; members of the NGATS Institute Management Council attend approximately one meeting per month. The challenge for JPDO is to maintain the interest and enthusiasm of nonfederal stakeholders, who will have to juggle their own multiple priorities and resource demands in order to maintain this level of participation when some tangible benefits may not be realized for several years.

Appendix V: Comments from the Department of Labor

U.S. Department of Labor

Assistant Secretary for
Employment and Training
Washington, D.C. 20210

AUG 16 2006

Mr. Gerald L. Dillingham
Director
Civil Aviation Issues
U.S. Government Accountability Office
441 G. Street, N.W.
Washington, D.C. 20548

Dear Mr. Dillingham:

The Employment and Training Administration (ETA) is in receipt of the draft Government Accountability Office (GAO) report entitled, "U.S. Aerospace Industry: Progress in Implementing Aerospace Commission Recommendations and Remaining Challenges." (GAO-06-920)

The report describes the activities of the President's High Growth Job Training Initiative for the aerospace industry and cites several experts who question whether this initiative will have significant impact given the scale of the workforce challenges confronting the industry. ETA believes it is important to recognize that the President's High Growth Job Training Initiative is designed to demonstrate innovative model solutions to these workforce challenges. These solutions may then be leveraged and replicated by the larger publicly-funded workforce investment system, in partnership with industry, education providers, and other stakeholders, utilizing formula funding under the Workforce Investment Act. ETA has produced the Workforce3One Web site (www.workforce3one.org) specifically to promote the best practices demonstrated under the High Growth Job Training Initiative, and to disseminate the practical tools and resources that have been developed with grant funding. Therefore, ETA believes its efforts can have substantial impact by leveraging the $10,494,000 investment in aerospace solutions through the WIA-funded workforce investment system.

Also, the overall purpose of the High-Growth Job Training Initiative is to model a demand-driven workforce investment system that understands and responds to businesses' changing competency and skill requirements. By moving to a demand-driven approach the public system will develop the ability to respond to the workforce challenges faced by the aerospace industry.

If you would like additional information, please do not hesitate to call me at (202) 693-2700.

Sincerely,

Emily Stover DeRocco

Emily Stover DeRocco

Appendix VI: Comments from the National Aeronautics and Space Administration

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

August 28, 2006

Mr. Allen Li
Director
Acquisition and Sourcing Management
United States Government Accountability Office
Washington, DC 20548

Dear Mr. Li:

NASA appreciates the opportunity to comment on the August 2006 draft of the Government Accountability Office (GAO) Report GAO-06-920 entitled "Progress in Implementing Aerospace Commission Recommendations and Remaining Challenges." While we agree with the majority of the content, we would like to emphasize four items that we think are important to convey.

First, as noted in the report, NASA's restructuring of its Aeronautics Program to ensure a strong focus on long-term, cutting-edge, fundamental research is well aligned with the Commission's recommendations. We want to ensure, however, that it is understood that NASA defines fundamental research as that research that includes continued, long-term scientific study in areas such as physics, chemistry, materials, experimental techniques, and computational techniques that leads to a furthering of our understanding of the underlying principles that form the foundation of the core aeronautics disciplines, as well as that research that integrates the knowledge gained in these core areas to significantly enhance our capabilities, tools, and technologies at the disciplinary (e.g., aerodynamics, combustion, dynamics and control, acoustics) and multidisciplinary (e.g., engine design, airframe design) level. We make this point because aeronautics is inherently multidisciplinary, and any investment in the foundational areas of physics, chemistry, etc., must be linked to long-term goals at the multidisciplinary level. NASA does not want people to assume that we will only be conducting basic research that is not tied to system-level objectives.

Second, NASA would like to point out the following comments taken directly from the Commission's report:

> *"Industry has the responsibility for leveraging government and university research and for transforming it into new products and services, quickly and affordably. But, the U.S. aerospace industry has not invested sufficiently to transition research into marketable products and services."*

and

> *"The Commission believes that the U.S. aerospace industry must take the leadership role in transitioning research into products and services for the nation and the world. To assist them, the government must provide industry with insight*

into its long-term research goals and programs. With this information, the industry needs to develop business strategies that can incorporate this research into new products and services. Industry also needs to provide an input to the government on its research priorities."

NASA's restructured Aeronautics Program is directly aligned with these recommendations, but we are concerned that this alignment is not reflected in the draft report.

Third, we greatly appreciate that the draft report accurately represents NASA's position regarding narrowly focused demonstrations, but we would like to emphasize that this does not mean that we will not be conducting flight test experiments. To the contrary, NASA intends to conduct flight test experiments across most of the projects in its portfolio, including partnering with the Department of Defense (DOD) in several efforts. For example, NASA will be working with the DOD on the X-51 program, which will leverage NASA's efforts in the recently completed Hyper-X program. Ground testing of the X-51 engine begins this year at the Langley Research Center, and flight testing is scheduled to begin in the 2008/2009 timeframe. NASA believes that it is not in the taxpayers' best interest to build large-scale flight vehicles that are duplicative of those being built by the DOD and that the Nation's interests are best served by partnering with the DOD rather than trying to compete with it. In fact, we have recently signed an MOU with the Air Force to codify such partnerships.

Finally, we are concerned that the draft report does not acknowledge that the restructured Aeronautics program will have a positive effect on university research. NASA's commitment to long-term, cutting-edge fundamental research has resulted in putting together a comprehensive NASA Research Announcement (NRA) process to ensure full and open competition in several research areas. More than 110 universities have submitted proposals in response to the NRA. These proposals are currently being reviewed.

We would like to make one final observation. While we agree with most of the figures presented regarding the NASA budget, the draft report incorrectly states that NASA's aeronautics research funding is projected to decrease by almost 50 percent by 2011. We want to make sure that the draft reflects that the Aeronautics budget has declined 18 percent from FY 2006 to FY 2007 and that the current budget projects flat funding thereafter.

In closing, NASA would again like to thank you for the opportunity to provide comments about the GAO draft report. We hope that these comments will be useful.

Sincerely,

Shana Dale
Deputy Administrator

Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

Gerald L. Dillingham, Ph.D. (202) 512-2834 or dillinghamg@gao.gov

Staff Acknowledgments

In addition to the above individual, Teresa Spisak, Assistant Director; Brad Dubbs; Elizabeth Eisenstadt; David Hooper; Heather Krause; Elizabeth Marchak; Edmond Menoche; Sara Ann Moessbauer; Faye Morrison; Josh Ormond; Tim Schindler; Richard Scott; John W. Stambaugh; Larry Thomas; and Dale Yuge made key contributions to this report.

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