

October 2005

NATIONAL AIRSPACE SYSTEM

Transformation will
Require Cultural
Change, Balanced
Funding Priorities, and
Use of All Available
Management Tools



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Highlights

Highlights of [GAO-06-154](#), a report to congressional requesters

Why GAO Did This Study

The National Airspace System (NAS) is a complex network of airports, aircraft, air traffic control (ATC) facilities, employees, and pilots. The aviation industry, which depends on the NAS, contributes about 9 percent to the gross domestic product. The Federal Aviation Administration (FAA), funded through a tax-financed trust fund and General Fund appropriations, is pursuing a multibillion-dollar modernization program. Persistent cost, schedule, and/or performance shortfalls have kept this program on GAO's list of high-risk programs since 1995. GAO was asked to review the status of NAS modernization. This report addresses NAS status by identifying the challenges that FAA faces in managing (1) infrastructure, (2) human capital, and (3) financial resources.

What GAO Recommends

To facilitate NAS modernization, GAO recommends that FAA (1) estimate controller hiring and training costs, (2) establish a long-term focus on developing a more results-oriented culture, (3) balance immediate and long-term investment needs, and (4) pursue options for improved system management and development.

In commenting on a draft of this report, agency officials described ongoing actions consistent with the third and fourth recommendations, but did not comment on the others. GAO believes that all four recommendations are needed.

www.gao.gov/cgi-bin/getrpt?GAO-06-154.

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

NATIONAL AIRSPACE SYSTEM

Transformation will Require Cultural Change, Balanced Funding Priorities, and Use of All Available Management Tools

What GAO Found

GAO's recent reports indicate that FAA has made progress in managing its infrastructure—the systems, facilities, airports, and navigation aids that comprise the NAS—but acquisition, security, and capacity challenges remain. FAA met its fiscal year 2004 acquisitions performance goal. This goal was consistent with the President's Management Agenda and represents a positive step. However, FAA needs to continue addressing four key factors that, as GAO has reported, have historically contributed to acquisitions' missing their original cost, schedule, and performance targets: (1) actual funding less than planned, (2) increases in projects' scope, (3) underestimates of software complexity, and (4) insufficient stakeholder involvement. To address these factors, FAA has begun to prioritize its investments by considering their potential to reduce operational costs and by developing a blueprint for information technology investment; but FAA still needs to secure information technology systems and expand the NAS's capacity for an expected 25 percent increase in air travel by 2015.

Human capital management challenges include hiring and training thousands of air traffic controllers to replace those expected to retire over the next decade and creating a results-oriented culture. FAA has developed a controller staffing plan, but has not estimated its cost, and therefore, cannot determine its impact on future budgets. Efforts to transform FAA's workforce culture address an impediment to ATC modernization that GAO has identified, but will require a sustained, multiyear commitment.

Rising costs and shrinking revenues pose financial management challenges. To manage costs, FAA is using a new cost accounting system and emphasizing accountability. However, in view of current and anticipated funding reductions, FAA has eliminated initial research and development funding for new technologies that could support the next-generation air transportation system. Some stakeholders and FAA officials are discussing potential changes to FAA's funding mechanism. Some experts, and GAO's work, suggest that FAA pursue near-term options, such as contracting out more services. After establishing a sound financial management record, FAA could pursue options for greater financial management flexibility.



Source: Photodisc, Getty Images.

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Abbreviations

ADS-B	Automatic Dependent Surveillance - Broadcast
ATC	air traffic control
ATO	Air Traffic Organization
ATOP	Advanced Technologies and Oceanic Procedures
CPDLC	Controller-Pilot Data Link Communications
DOD	Department of Defense
ECG	En Route Communications Gateway
ERAM	En Route Automation Modernization System
FAA	Federal Aviation Administration
FTI	Federal Telecommunications Infrastructure
GPS	Global Positioning System
JPDO	Joint Planning and Development Office
LAAS	Local Area Augmentation System
NAS	National Airspace System
NEXCOM	Next Generation Air/Ground Communications
STARS	Standard Terminal Automation Replacement System
SWIM	System Wide Information Management System
TAMR	Terminal Automation Modernization Replacement
WAAS	Wide Area Augmentation System

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United States Government Accountability Office
Washington, D.C. 20548

October 14, 2005

The Honorable Tom Davis
Chairman
The Honorable Henry A. Waxman
Ranking Minority Member
Committee on Government Reform
House of Representatives

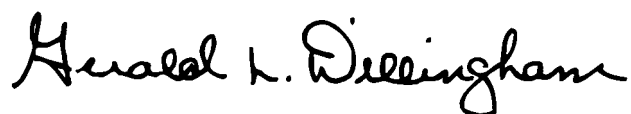
The Honorable Don Young
Chairman
The Honorable James L. Oberstar
Ranking Democratic Member
Committee on Transportation and Infrastructure
House of Representatives

The Honorable John L. Mica
Chairman
The Honorable Jerry F. Costello
Ranking Democratic Member
Committee on Transportation and Infrastructure
House of Representatives

In response to your request, this report discusses the status of national airspace modernization and the challenges that the Federal Aviation Administration (FAA) faces in managing its infrastructure, human capital, and financial resources. The report contains recommendations to the Secretary of Transportation to ensure that FAA (1) follows through with its efforts to improve workforce culture; (2) balances current and long-term investment priorities; and (3) in the near term, fully uses all existing flexibilities to reduce costs and manage revenues, and, in the longer term, determines whether a business case exists to pursue more extensive changes, such as those requiring legislation.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution of it until 30 days from the date of this letter. At that time, we will send copies of this report to interested congressional committees and the Secretary of Transportation. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please call me at (202) 512-2834 or dillingham@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 Tamara Dorland, Seth Dykes, Bess Eisenstadt, Brandon Haller, Maren McAvoy, Edmond Menoche, Beverly Norwood, and Mark Ramage.



Gerald L. Dillingham
Director, Physical Infrastructure Issues

Executive Summary

Purpose

Since 1981, the Federal Aviation Administration (FAA) has been conducting a program to modernize the National Airspace System (NAS) at a cost of \$43.5 billion, to date. In 2003, Congress passed legislation to create the Next Generation Air Transportation System Joint Planning and Development Office (JPDO) to transform the NAS to meet the potential air travel demands of 2025. The NAS's infrastructure includes the air traffic control (ATC) system, which relies on an extensive array of information technology systems, including radars, automated data processing, navigation and communications equipment, and ATC facilities. The NAS's infrastructure also includes over 215,000 commercial and recreational aircraft as well as more than 19,000 airports. The aviation industry is critical to the nation's economic health, contributing about 9 percent to the gross domestic product. However, the ability of the NAS to accommodate increasing volumes of air traffic is limited, in part, to airport capacity, as well as the efficiency with which aircraft utilize the finite amount of airspace available in the vicinity of airports and at cruising altitudes. The JPDO is beginning to plan a multiagency effort to create the Next Generation Air Transportation System (NGATS), intended to triple the capacity of the current NAS. The NAS's human capital includes FAA's 50,000 employees—the air traffic controllers who guide aircraft as they take off, land, and fly between airports—and others who certify the safety of aircraft and equipment, manage ATC modernization projects, maintain NAS systems, and provide support services. Finally, the NAS's financial resources are vitally important to ensure that it continues to meet the nation's mobility needs. From fiscal years 2000 through 2004, FAA's annual budget increased from \$10.9 billion to approximately \$14 billion; however, in fiscal year 2005, FAA received substantially less in capital funding than in prior years. FAA anticipates lean capital budgets for the immediate future, which enhances the need for FAA to manage its resources effectively.

In 1995, GAO designated the ATC modernization program—a major component of NAS modernization—as a high-risk information technology initiative because of its size, complexity, cost, and problem-plagued past.¹ FAA also faces challenges in expanding NAS capacity to accommodate future increases in demand for air travel as well as in hiring and training thousands of air traffic controllers to replace those expected to retire in the next decade. Additionally, FAA has attempted to change its workforce culture to one that stresses mission focus, coordination, accountability, and adaptability, but the agency has not provided the sustained leadership needed for lasting cultural change.²

Concerned about the challenges facing ATC modernization, the Chairman and Ranking Minority Member, House Committee on Government Reform, and the Chairmen and Ranking Democratic Members of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation asked GAO to provide an overall assessment of the status of NAS modernization. This report addresses the status of ATC modernization as well as other NAS components, by answering the following research question: What challenges does FAA face in managing three distinct areas: (1) infrastructure, (2) human capital, and (3) financial resources? This report is based on FAA documents and briefings as well as reviews and summaries of related GAO work. GAO also convened an international panel of experts to discuss the challenges of FAA's NAS modernization efforts and the prospects that the Air Traffic Organization (ATO)—a recently created subunit of FAA—holds for improving modernization management. In addition, GAO interviewed key stakeholders representing labor, commercial airlines, general aviation, and the Department of

¹GAO, *High-Risk Series: An Update*, [GAO-05-207](#) (Washington, D.C.: Jan. 1, 2005). In August 2005, FAA submitted a plan to the Office of Management and Budget to remove ATC modernization from GAO's high-risk list. FAA submitted this plan in response to a request from the Office of Management and Budget, which had asked agencies with programs on GAO's high-risk list to identify their goals for reducing fraud, waste, or mismanagement. Although the request specified that the purpose of the plans was not to get agency programs off the high-risk list, FAA intends to use the activities described in the plan as means for doing so, according to a Department of Transportation official.

²“Organizational culture” is the underlying assumptions, beliefs, values, attitudes, and expectations shared by an organization's members that affect their behavior and the behavior of the organization as a whole.

Defense (DOD). This report discusses all aspects of the NAS except airline employees and FAA's aircraft and equipment safety assurance operations.³ (See ch. 1 for additional information on GAO's objective, scope, and methodology).

Background

GAO has issued numerous reports on FAA's difficulty in meeting cost, schedule, and/or performance targets, as well as on FAA's management of information technology, which is at the heart of many modern ATC systems. GAO has also reported on FAA's efforts to expand NAS capacity and reduce delays, and on FAA's human capital challenges, such as the need to hire and train thousands of air traffic controllers in the coming decade to replace those becoming eligible to retire. Finally, GAO has pointed out that FAA's acquisitions were impaired because employees acted in ways that did not reflect a strong commitment to mission focus, accountability, coordination, and adaptability.⁴

Congress and others have taken steps to address these issues. For example, Congress exempted FAA from federal personnel and acquisition regulations in 1995, after the 1993 National Performance Review found, and FAA asserted, that these regulations impeded its ability to properly manage the ATC modernization program. In 1997, the congressionally appointed National Civil Aviation Review Commission recommended that FAA's management become more performance-based and that changes be made in how FAA is funded. In December 2000, President Clinton signed an executive order, and Congress passed, supporting legislation that, together, provided FAA with the authority to create the performance-based ATO to control and improve FAA's management of the modernization effort. In February 2004, FAA reorganized, transferring 36,000 employees, most of whom worked work in air traffic services and research and acquisitions, to the ATO.

³For reports on airline employees and aircraft and equipment safety assurance workforce and procedures, see, for example, GAO, *Aviation Safety: FAA Needs to Update the Curriculum and Certification Requirements for Aviation Mechanics*, [GAO-03-317](#) (Washington, D.C.: Mar. 6, 2003); *Human Factors: FAA's Guidance and Oversight of Pilot Crew Resource Management Training Can Be Improved*, [GAO/RCED-98-7](#) (Washington, D.C.: Nov. 24, 1997); and *Aviation Safety: Safer Skies Initiative Has Taken Initial Steps to Reduce Accident Rates by 2007*, [GAO/RCED-00-111](#) (Washington, D.C.: June 28, 2000).

⁴GAO, *Aviation Acquisition: A Comprehensive Strategy Is Needed for Cultural Change at FAA*, [GAO/RCED-96-159](#) (Washington, D.C.: Aug. 22, 1996).

In 2003, Congress authorized creation of a Joint Planning and Development Office (JPDO) to create and carry out an integrated plan to develop the next generation air transportation system, capable of meeting potential air traffic demand by 2025. While NAS modernization has previously been mainly under the purview of FAA, with a 10-year planning horizon, the JPDO is charged with coordinating research activities of multiple agencies, including FAA, to coordinate a 20-year research and development program.

Results in Brief

As GAO reported, FAA has taken many positive steps to improve the management of its infrastructure, but it still faces significant challenges. FAA met its acquisition performance goal for 2004, which indicates a good start in addressing the factors that contributed to past system acquisition problems. However, FAA will need to continue addressing four key factors that, as GAO has reported, have historically contributed individually or collectively to acquisitions missing their original cost, schedule, and performance targets: (1) acquisitions receiving less funding than called for in agency planning documents, (2) adding requirements and/or unplanned work, (3) underestimating the complexity of software development, and (4) not sufficiently involving stakeholders throughout system development.⁵ To address these and other issues that GAO has identified, FAA has taken some actions, but in some cases, needs to do more. For example, to improve its acquisition of software-intensive ATC systems, FAA developed a process improvement model, but did not mandate the model's use throughout the organization. In response to GAO's recommendation that it do so, FAA has begun developing a requirement that projects have process improvement activities in place before seeking approval from the FAA investment review board. Moreover, GAO has reported that FAA's acquisition management system does not ensure the use of a knowledge-based approach found in the best practices for managing commercial product developments. Commercial best practices call for specific knowledge to be captured and used by corporate-level decision makers to determine whether an acquisition has reached a level of development (product maturity) sufficient to move forward in the acquisition process. Additionally, while FAA has begun to develop its NAS enterprise architecture—a blueprint to guide and constrain its information technology investments—the agency needs to do more to achieve the architecture's

⁵GAO, *The National Airspace System: FAA Has Made Progress but Continues to Face Challenges in Acquiring Major Air Traffic Control Systems*, [GAO-05-331](#) (Washington, D.C.: June 10, 2005).

full benefits. Another challenge is protecting information technology systems—an issue that has been on GAO’s high-risk list since 1997. GAO recently reported that FAA faces critical needs in protecting its information technology-intensive ATC systems from inadvertent or intentional disruption.⁶ Finally, FAA will be challenged to expand NAS capacity to accommodate anticipated increases in air travel. To this end, FAA is supporting the development of new runways and airports, and is redesigning flight patterns to make more efficient use of airspace as aircraft take off, cruise, and land.

FAA’s major human capital challenges include hiring and training thousands of air traffic controllers to replace those expected to retire, and transforming the agency’s organizational culture. First, FAA will need to hire and train thousands of air traffic controllers in the next decade to replace those who were hired after the air traffic controllers’ strike in 1981. As GAO recommended in 2002,⁷ FAA developed a comprehensive plan for this hiring and training effort. The plan describes expected recruitment sources, planned revisions to ATC facility staffing standards, a screening process to eliminate potentially unsuccessful candidates, and proposed upgrades to controller training facilities. To mitigate the costs of the controller training and hiring program, FAA’s plan includes a number of steps that the agency expects will reduce controller staffing requirements by 10 percent. However, FAA has not calculated the savings that each step will achieve or the total cost of hiring and training. As a result, FAA cannot estimate the impact of the hiring and training effort on future budgets. As of June 2005, FAA was studying a proposal that could save costs by allowing potential controllers, after graduating from aviation-related college programs, to bypass FAA’s controller training academy and immediately start their on-the-job training at an ATC facility. Second, FAA’s workforce culture remains a concern. Responding to GAO’s 1996 finding that FAA’s workforce culture impaired its acquisitions, the agency developed a strategy for cultural change, but did not sustain its efforts. FAA is now developing baseline data for measuring the progress of its cultural transformation. FAA’s recent action is a good first step, but continued management focus and commitment will be needed for success in this area,

⁶GAO, *Information Security: Progress Made, but Federal Aviation Administration Needs to Improve Controls Over Air Traffic Control Systems*, GAO-05-712 (Washington, D.C.: Aug. 26, 2005).

⁷GAO, *Air Traffic Control: FAA Needs to Better Prepare for Impending Wave of Controller Attrition*, GAO-02-591 (Washington, D.C.: June 14, 2002).

since, as we have reported, at least 5 years is needed to achieve cultural change.⁸

In managing its financial resources, FAA faces the dual challenges of rising costs and declining revenues that it projects will produce an \$8.2 billion gap between expected budget targets and expected spending requirements through fiscal year 2009.⁹ FAA is striving to live within its reduced means by focusing on cost control and prioritizing projects. However, these actions will not come close to eliminating the gap, and some actions, such as cutting funding for new technology, come at the expense of future goals. For example, FAA eliminated \$1.4 billion planned for early research, which included research on two systems that FAA had described as “cornerstones” of the NAS of the future. These technologies could have supported the JPDO’s vision for the next generation air transportation system. As the expiration for the Aviation and Airway Trust Fund (Trust Fund) and FAA’s reauthorization—both scheduled for 2007—approach, FAA officials, aviation experts, and stakeholders are discussing how to better align FAA’s revenue structure with actual costs and changes in the aviation industry. Over half of the Trust Fund’s income now comes from a ticket tax, which some stakeholders believe is not linked to FAA’s costs. A congressionally appointed commission made a similar recommendation in 1997, that the FAA’s revenue stream become more cost based. Some experts suggested that FAA work toward changes that would be possible within the existing federal structure, such as improving its process for prioritizing programs or exploring further options for contracting out services. Others maintained that the ATO’s relationship with Congress must change to allow the ATO to manage its own finances. GAO has reported that to address the challenges of the 21st Century, the nation needs to fundamentally reexamine such governance issues. In GAO’s view, FAA could adopt a two-staged approach to address its financial management challenges: In the near term, make changes that are possible within the federal structure and establish a record of sound financial management. Over the longer term, determine whether sufficient evidence exists to develop a business case for more fundamental changes that could permit greater financial management flexibility.

⁸GAO, *Results-Oriented Cultures: Implementation Steps to Assist Mergers and Organizational Transformations*, [GAO-03-669](#) (Washington, D.C.: July 2, 2003).

⁹In this report, the term “budget targets” means the outyear budgets provided by the Office of Management and Budget.

Principal Findings

FAA Has Made Changes to Improve Infrastructure Management, but Acquisition, Security, and Capacity Challenges Remain

GAO's recent reports on FAA's management of its infrastructure indicate that FAA has responded to several past recommendations, but needs to do more work to address continuing challenges. For example, FAA met its acquisition performance goal for fiscal year 2004—to meet 80 percent of designated milestones and maintain 80 percent of critical program costs within 10 percent of the budget, as published in FAA's Capital Investment Plan. This represents a good start. However, because the goal uses cost or schedule milestones that are set for each fiscal year, it needs to be viewed in the context of FAA's long-term acquisition performance. For example, during 2005, FAA plans to make changes to three major system acquisitions, effectively resetting the program milestones and cost targets against which it measures annual performance. Hence, this performance goal does not provide a consistent benchmark—such as the cost and schedule targets set at an acquisition's inception—for assessing progress over time. These annual performance targets should continue to be viewed in the broader context of acquisitions' original and revised baselines, and the variance reports provided to the FAA administrator and to Congress.

FAA still faces challenges in addressing four factors that GAO found to be the cause of acquisitions missing their original cost, schedule, and/or performance targets. These factors—funding shortfalls, requirements growth and/or unplanned work, insufficient stakeholder involvement, and underestimation of software complexity—individually or collectively contributed to these problems and often interacted. For example, when developing a satellite navigation system, FAA underestimated the complexity of the system's software as it compressed the development schedule. This underestimate then contributed to unplanned work, cost increases, and schedule delays.

To address these four factors and improve its general management of system acquisitions, FAA has taken several steps, but in a number of cases, it needs to do more. For example, FAA has obtained substantial benefits by developing and using a process improvement model in a number of software-intensive system acquisitions. FAA has begun developing a requirement that projects have process improvement activities in place before seeking approval from the FAA investment review board, as GAO recommended.¹⁰ Also in response to a GAO recommendation, FAA officials reported that they have improved the agency's investment portfolio management through semiannual reviews of in-service systems.¹¹ FAA also changed its format for justifying major technology investments to a format prescribed by the Office of Management and Budget. However, FAA's acquisition management system still lacks a knowledge-based approach consistent with commercial best practices. Knowledge-based approaches ensure that, as acquisitions progress, officials obtain knowledge at specific junctures of an acquisition cycle, or knowledge points, thereby decreasing the risk of cost growth and schedule delays. Finally, although FAA has begun to develop a NAS enterprise architecture, it has not completed the architecture that it needs to manage its information technology investments.¹² GAO's experience with federal agencies has shown that making information technology investments without defining these investments in the context of an architecture often results in duplication, poor integration, and unnecessary costs.

GAO's most recent report on FAA's efforts to provide security for its information technology-intensive ATC systems notes that FAA needs to take steps to do more to protect these systems from inadvertent or intentional disruption.¹³ While FAA has established an information security program, the agency has not fully implemented it. As a result, GAO found outdated security plans, a lack of security awareness training, limited incident detection capabilities, and shortcomings in service continuity

¹⁰GAO, *Air Traffic Control: System Management Capabilities Improved, but More Can Be Done to Institutionalize Improvements*, [GAO-04-901](#) (Washington, D.C.: Aug. 20, 2004).

¹¹GAO, *Information Technology: FAA Has Many Investment Management Capabilities in Place, but More Oversight of Operational Systems Is Needed*, [GAO-04-822](#) (Washington, D.C.: Aug. 20, 2004).

¹²GAO, *Federal Aviation Administration: Stronger Architecture Program Needed to Guide Systems Modernization Efforts*, [GAO-05-266](#) (Washington, D.C.: Apr. 29, 2005).

¹³[GAO-05-712](#).

plans. GAO also found weaknesses that threaten the integrity, confidentiality, and availability of these systems, including weaknesses in controls over who can obtain access. Accordingly, GAO recommended several actions intended to improve FAA's information security program. FAA agreed to consider our recommendations, but expressed concern that we had overstated the system's vulnerability to disruption. We acknowledged that FAA may have other protections built into its overall system architecture. However, because these systems are interconnected, the weaknesses we identified in the systems that we reviewed may increase the risk to other systems.

To accommodate an expected 25 percent increase in air travel, many airports are building new runways. FAA is leveraging the benefits of new and existing runways by redesigning flight procedures to allow properly equipped aircraft to take off, cruise, and land with reduced separation while maintaining safety.

Human Capital Management Challenges Include Hiring Air Traffic Controllers and Transforming FAA's Organizational Culture

During the next decade, FAA will need to replace thousands of air traffic controllers who will become eligible for retirement. During the 1980s and early 1990s, FAA hired large numbers of controllers to replace those who were fired when they went on strike in 1981. As a result, most of the current workforce will become eligible for retirement over the next 10 years. In December 2004, responding to GAO's recommendation,¹⁴ FAA issued a hiring and training plan. To mitigate the cost of the plan, FAA plans to rely on part-time employees and job-sharing arrangements. However, the plan does not disclose the cost of hiring and training controllers, and agency officials could not provide any analyses to support the plan's estimates of cost savings. Hence, the impact of this hiring and training program on future budgets is unclear. If FAA experiences shortages in controller staffing, the agency plans to maintain safety by slowing the traffic flow, which could result in delays. In June 2005, FAA began considering whether prospective controllers who graduate from aviation-related programs in certain colleges could bypass the currently required academy training and instead proceed directly to an ATC facility to begin on-the-job training. Such a change in the training program holds potential for cost savings and is endorsed by union officials and by one of the colleges that prepares graduates for careers in aviation.

¹⁴GAO-02-591.

FAA has implemented a number of human capital reforms in response to an exemption from federal personnel management regulations. FAA replaced the traditional civil service pay system with a series of pay bands and specific job categories that have minimum and maximum pay rates spanning two to five pay bands. FAA also established its own hiring program, a flexible system for adjusting the number of executive-level positions, and a new performance management system.

FAA is taking steps to create a results-oriented culture, addressing a factor that we identified as an impediment to ATC modernization in 1996. Recognizing the importance of organizational culture in achieving results, FAA's human capital plan includes a goal to create a results-based performance culture. Furthermore, FAA is using the results of its most recent employee attitude survey as a baseline to assess the organization's progress in adopting five core values that the management team selected. The core values are (1) integrity and honesty, (2) accountability and responsibility, (3) commitment to excellence, (4) commitment to people, and (5) fiscal responsibility. FAA's actions are good first steps, but continuous management attention over the next several years will be crucial to achieving the cultural change that FAA is seeking. GAO's work has highlighted the importance of recognizing organizational culture as a step in implementing mergers and transformations and has found that achieving cultural change typically takes 5 to 7 years or longer.¹⁵ In the past, FAA's efforts at cultural change lacked follow-through and continuity. While there was some improvement in securing a more results-oriented culture, as measured by employee responses to surveys in 1997 and 2000, progress leveled off between the 2000 and the 2003 surveys.

Rising Costs and Declining Revenues Pose Financial Management Challenges

FAA projects that rising costs and reduced budgets will create a cumulative gap of \$8.2 billion between expected budget targets and expected spending requirements through fiscal year 2009. FAA's budget targets for capital for each year through fiscal year 2009 will be 17 percent less, on average, than the annual appropriations it received in fiscal years 2002 through 2004. Additionally, recent trends in the Trust Fund, which provides most of FAA's funding, have raised concerns. Since 2002, FAA has spent more than the Trust Fund has taken in, and the Trust Fund's uncommitted balance has declined by nearly 50 percent. Although revenues increased in 2004, FAA's

¹⁵GAO-03-669.

expenditures increased more. FAA is striving to live within its reduced means by cutting programs and focusing on cost control. For example, for fiscal year 2005, after an intensive review of its capital investment portfolio, FAA suspended the acquisition of a digital communications data link and a precision landing system augmented by satellites, and terminated a major component of a new digital communications system. Additionally, FAA has begun to implement a new cost accounting system, as GAO has long advocated. GAO had previously reported that FAA lacked the cost information necessary for decision making and for adequate accounts of its activities and major projects, such as the air traffic control modernization program. FAA also expects to save about \$450 million over 5 years through cost-reduction measures such as contracting out its flight service stations. However, FAA is not likely to meet its financial challenges through savings, given other pressing needs. FAA has had to significantly cut capital funding aimed at providing future benefits in order to remain within expected appropriations, while providing \$4.2 billion for 16 major system acquisitions through 2009. For example, in its 2005 through 2009 capital investment plan, FAA eliminated the \$1.4 billion that it had set aside for what it calls the “architecture segment,” which would have supported initial research and development of new technologies, prior to initiating formal acquisition programs. This reduction comes at an inopportune time, as the JPDO begins its efforts to coordinate the research of FAA and other federal agencies to transform the NAS to meet potential capacity needs in 2025. FAA also cut nearly \$790 million from its planned investments for facilities. While FAA has replaced many ATC facilities in the last 5 years, the funding reduction could delay progress on ATC facilities that are scheduled for repair or replacement in the future.

In anticipation of the Trust Fund’s expiration and FAA’s reauthorization, both scheduled for 2007, FAA officials, aviation experts, and stakeholders are debating the appropriateness of the current revenue structure and are reiterating some of the recommendations made in the past, such as those that the National Civil Aviation Review Commission made in 1997. Many stakeholders and aviation experts, as well as Department of Transportation officials, have suggested in various forums that FAA’s funding mechanism needs to be changed to one that is more closely aligned with FAA’s costs. FAA’s 2004 performance report notes that the current revenue structure is heavily reliant on the number of airline passengers in the NAS, while FAA’s workload and costs are driven by the number of aircraft operating in the NAS. Some experts stated that to effectively manage its acquisitions, FAA needs multiyear funding, financed by debt if necessary, as the commission recommended. Others suggested that FAA take steps in the near term to

reduce costs within the existing structure of congressional oversight and financial control, such as exploring additional opportunities to contract out night-time ATC services. Others went so far as to state that FAA cannot fully address legacy modernization problems without complete managerial and budgetary independence. GAO has reported that to address the challenges of the 21st Century, the nation needs to fundamentally reexamine what the government should do, how it should do business, and how it should be financed. GAO believes that in the near term, FAA must pursue currently available options, such as exploring additional opportunities for contracting out services and pursuing other cost-saving measures, and demonstrate improvement in its ability to manage its costs. After fully exploiting these options, and establishing a record of improved financial management, FAA could consider longer term changes by reexamining fundamental issues such as the appropriate government role in aviation and the funding mechanism that supports the ATC system. Ultimately, Congress and the President will decide these issues.

Recommendations for Executive Action

GAO is recommending that FAA take the following four actions: (1) estimate the cost of its controller hiring and training plan and provide for these costs in future budget requests; (2) provide the long-term commitment to transforming the culture to become more results oriented so that the change takes root; (3) balance current and long-term investment priorities; and (4) use all available management tools and, after establishing a record of improved financial management, explore more fundamental changes that could provide greater financial management flexibility.

Agency Comments and GAO Evaluation

GAO provided a draft of this report to the Department of Transportation for its review and comment. In response, ATO managers; FAA's Chief Information Officer; and the Acting Director, Office of Financial Controls, provided oral comments. ATO managers noted that GAO's recommendations on balancing current and long-term investment priorities and using all available financial management tools may not be necessary because FAA is taking actions consistent with these recommendations. According to FAA, the agency's balancing of current and long-term investment priorities will be reflected in its fiscal year 2007 budget request, which was being formulated in parallel with GAO's work. GAO is retaining this recommendation because it pertains not only to fiscal year 2007, but to future years as well. FAA also commented that it is using all available management tools, including examining alternative funding mechanisms.

GAO believes that FAA needs to pursue additional cost saving tools, such as exploring further opportunities to contract out services; consolidate major facilities; and accelerate decommissioning of ground-based navigation aids, as GAO has noted in this report. Therefore, GAO is retaining the recommendation to this effect. FAA did not comment on the other recommendations. FAA provided technical comments and clarifications throughout the report, which GAO incorporated as appropriate.

Introduction

FAA Manages the National Airspace System, a Complex Collection of Systems and Infrastructure

The Federal Aviation Administration’s (FAA) mission is to provide the safest, most efficient aerospace system in the world. This system, known as the National Airspace System (NAS), consists of (1) infrastructure (systems, procedures, facilities, airports and aircraft, communications equipment, satellite navigation aids, and radars); and (2) human capital (the people who make the NAS work—commercial, military, and general aviation pilots and airline dispatchers, and FAA employees, including equipment maintenance technicians and air traffic controllers who work in airport towers, and terminal area, en route, and oceanic air traffic control (ATC) centers. (See table 1.)

Table 1: NAS Overview

Infrastructure	Approximate number
Airports	19,500
Aircraft (large, regional, and general aviation)	215,000
En route control centers	21
Oceanic control centers	3
Terminal radar approach facilities	162
Ground-based navigational aids	2,200 ^a
Human capital	
FAA’s Air Traffic Controllers	15,000
Other FAA employees	35,000
Pilots	600,000

Source: FAA.

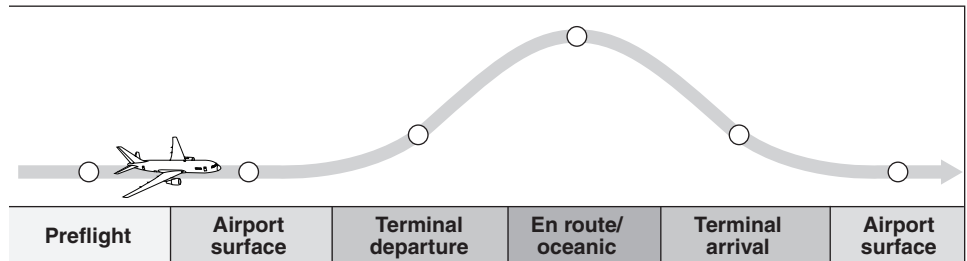
^aIncludes approximately 950 nondirectional beacons owned by local governments and other entities.

The NAS covers every aspect of aviation in the United States, beginning with the aircraft itself. FAA certifies aircraft as safe to operate in the NAS, from the earliest stages of design to 30 years after entry into service. FAA also certifies the NAS’s practices, personnel, and spare parts. Additionally, FAA sets standards for the construction and operation of the public and private airports located throughout the NAS.

On a larger scale, the NAS is a highly technical system and includes some 36,000 pieces of equipment operating in hundreds of locations throughout the United States. This equipment can range from a single navigation beacon in Brooke, Virginia, to an air route traffic control center, such as that in Oberlin, Ohio, that handles en route traffic. The mission of this

highly integrated system is to support all phases of flight for aircraft in the United States, from initial flight planning to successful takeoff, en route operations, and landing. (See fig. 1.)

Figure 1: Phases of Flight



Source: FAA.

Definitions of phases of flight:

Preflight: The period before the aircraft starts to move. It includes an extended strategic planning period that precedes flights. During this period, air traffic controllers compare the amount of traffic in the NAS with available capacity and develop initial strategies to mitigate any imbalances.

Airport surface: The periods from the terminal gate to takeoff and from touchdown to the terminal gate at the destination. Air traffic controllers in airport towers control aircraft during this phase.

Terminal departure and terminal arrival: The periods immediately following takeoff, when the aircraft initially climbs from the origination airport, and toward the end of a flight, when the aircraft descends to the destination airport. Air traffic controllers in airport towers control aircraft during the initial moments after takeoff and prior to landing, when the aircraft is within 5 nautical miles of the airport and up to 3,000 feet above the airport. Air traffic controllers at terminal approach control facilities, called TRACONS, control aircraft from the point where the airport tower's control ends to approximately 50 miles from the airport.

En route: The phase that occurs between terminal areas, including the climb, cruise, and decent phases of the flight. Air traffic controllers at air route traffic control centers control aircraft during the en route phase of

flight, and in some areas of the country, also control aircraft during the arrival and departure phases.

Oceanic: Analogous to the en route phase, except the aircraft is operating in oceanic air space, where there are fewer communication, navigation, and surveillance capabilities than are available over land.

The ATC system, which is a principal component of the NAS, comprises a vast network of radars; automated data processing, navigation and communication equipment; and air traffic control facilities. About 15,000 air traffic controllers control aircraft in the system and provide critical data throughout every stage. They work in the 162 terminal radar control facilities, the 21 air route traffic control centers that manage aircraft in the en route environment, and the 3 oceanic control centers. All of these control centers are linked and managed through the Air Traffic Control System Command Center in Herndon, Virginia. The NAS also includes thousands of navigational aids throughout the United States that provide critical location information to pilots at all stages of their operations.¹

The nation's 19,500 airports are key components of the NAS, as they serve as gateways to air travel. Several of the nation's largest airports, such as Chicago's O'Hare, New York's LaGuardia, and Atlanta's Hartsfield, are at capacity and need immediate improvements. Because the NAS functions as an interdependent network, delays at these airports can quickly create a "ripple" effect of delays that affects many airports across the country. For example, flights scheduled to take off from these airports may find themselves being held at the departing airport due to weather or limited airspace. Similarly, an aircraft late in leaving the airport where delays are occurring may be late in arriving at its destination, thus delaying the departure time for that aircraft's next flight.

The current NAS continues to reflect its origins as a system in which aircraft flew directly between ground-based navigational aids along FAA-defined routes. The existing airspace structure and boundary restrictions strongly reflect the constraints that communication and computer systems imposed as the NAS developed over the past 80 years. The advanced information technology available today, such as satellite navigation systems onboard aircraft, digital communication, and computer decision-

¹A navigation aid is any visual or electronic device, airborne or on the surface, that provides point-to-point guidance information or position data to aircraft in flight.

support systems, holds potential for increasing airspace capacity, improving aviation safety, and providing efficiencies to aircraft operators and service providers.² FAA is working to harness this new technology by transitioning the NAS from a ground-based system to a hybrid that uses both ground-based and airborne systems, thereby allowing pilots to be the primary decision makers as they navigate their aircraft, while controllers intervene only by exception. Making this transition requires that procedures, roles, responsibilities, equipment, and automation functions evolve into a structure that gives users greater flexibility in planning and conducting flights.

Such an evolution is a key component of the Joint Planning and Development Office's (JPDO) vision for the Next Generation Air Transportation System. In 2003, Congress directed the Secretary of Transportation to establish the JPDO to create, among other things, an integrated plan to ensure that the future air transportation system meets safety, security, mobility, efficiency, and capacity needs of the year 2025.³ The JPDO is expected to operate in conjunction with relevant programs in the National Aeronautics and Space Administration; the Departments of Defense, Commerce, and Homeland Security; and other agencies as needed. The JPDO published a report in December 2004 that describes the need for change in the NAS over the next 20 years.⁴

FAA receives most of its funding from the Airport and Airway Trust Fund (Trust Fund), which was established by the Airport and Airway Revenue Act of 1970⁵ to help fund the development of a nationwide airport and airway system as well as investments in air traffic control facilities. The Trust Fund receives most of its income from a number of taxes paid by passengers or airlines. (See fig. 2.) It funds the Airport Improvement Program, which provides grants that airports use in combination with other funding sources to finance construction and safety projects; capital

²The term "service provider" refers to anyone who furnishes NAS users with separation assurance, traffic management, infrastructure management, aviation information, navigation, landing, airspace management, search and rescue, or aviation assistance services.

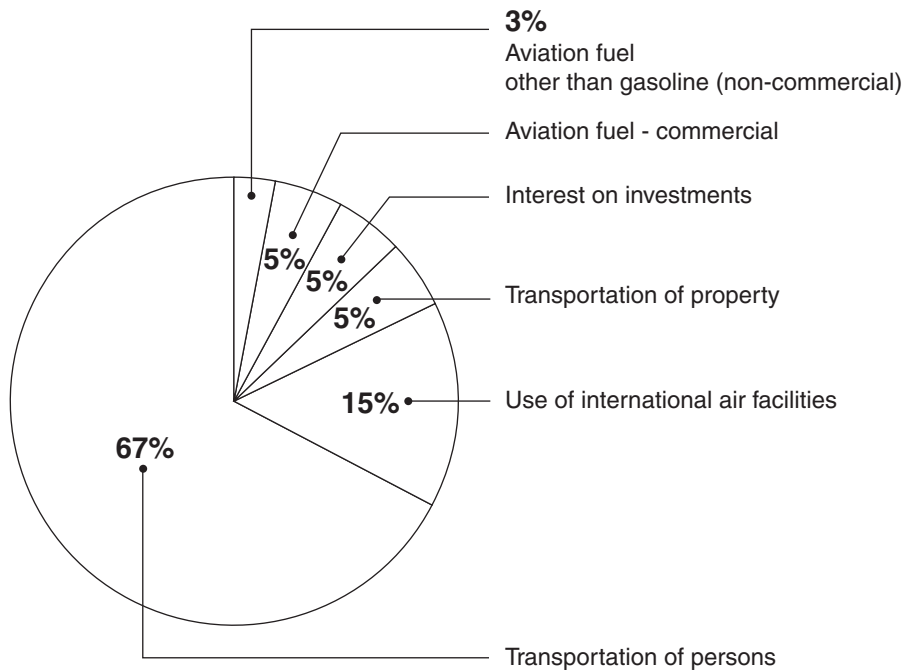
³P.L. 108-176, December 12, 2003.

⁴Joint Planning and Development Office, *Next Generation Air Transportation System: Integrated Plan* (Washington, D.C.: Dec. 12, 2004).

⁵P.L. 91-258.

expenditures; and the Research, Engineering, and Development account. (See fig. 3.) The General Fund provided 40 percent of FAA's operating funds and 22 percent of FAA's total budget in fiscal year 2004.

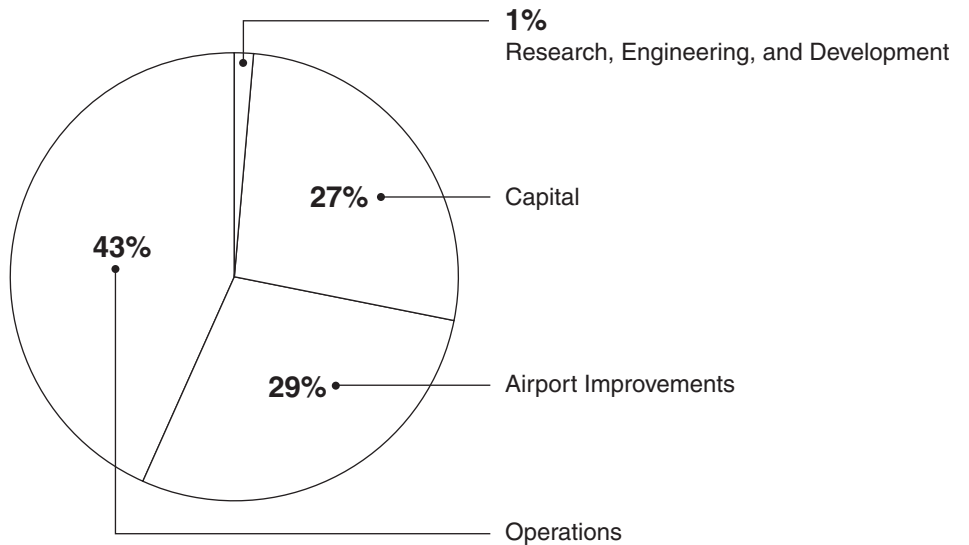
Figure 2: Trust Fund Revenue Sources, Fiscal Year 2004



Source: GAO analysis of FAA data.

Note: Transportation of persons includes domestic passenger ticket taxes, domestic flight segment fees, rural airports ticket taxes, and frequent flyer taxes. In the past, FAA had reported estimates of each of these taxes based on an internal allocation formula. Under that formula, passenger ticket taxes contributed about half of the Trust Fund's revenues. The Trust Fund also receives tax revenue from the sale of noncommercial aviation gasoline. In fiscal year 2004, this tax contributed 0.3 percent of Trust Fund revenues.

Figure 3: Trust Fund Expenditures by Category, Fiscal Year 2004

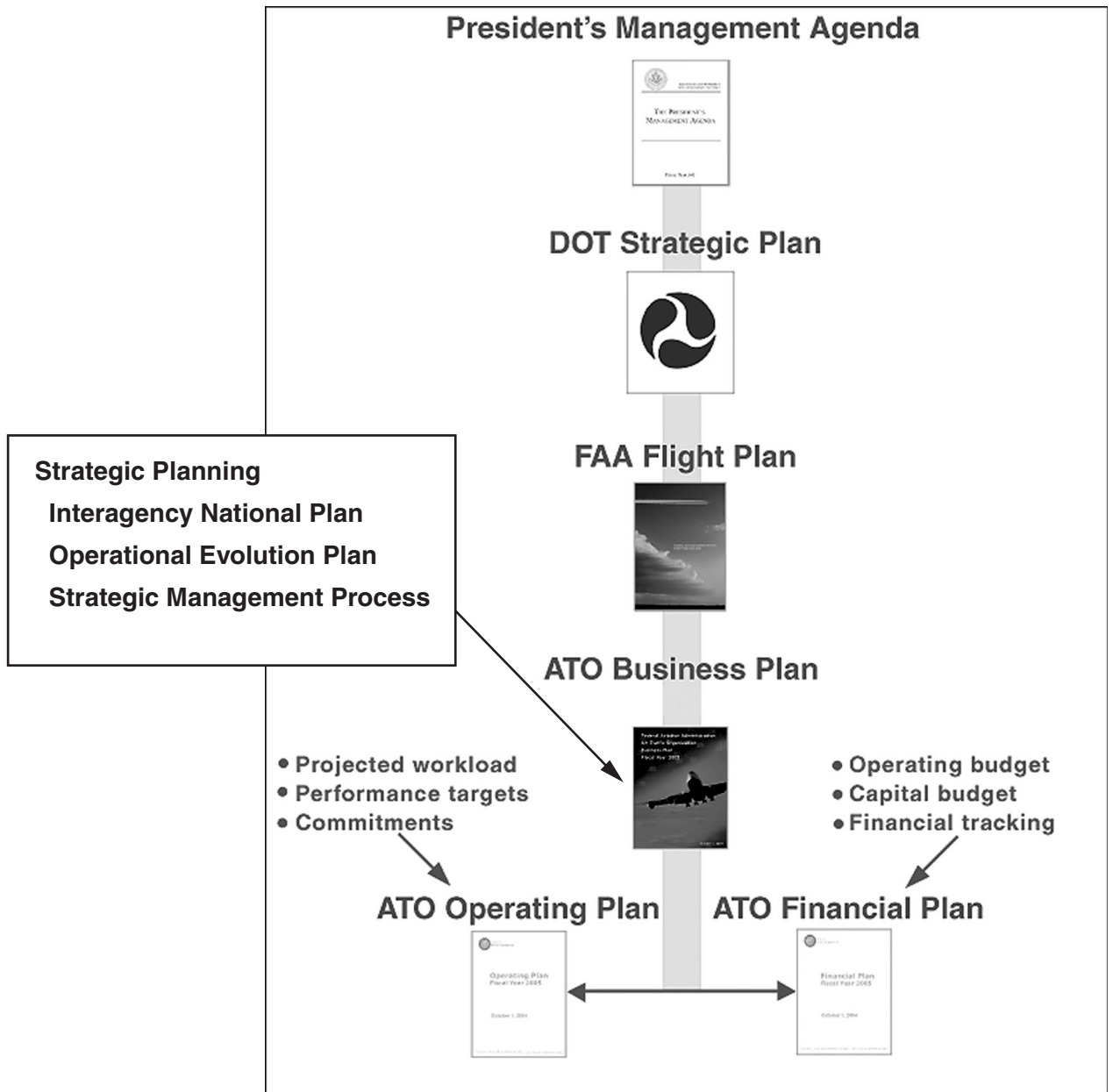


Source: GAO analysis of FAA data.

To organize its efforts to manage the NAS, FAA has developed a variety of plans, which it links to the President's Management Agenda.⁶ (See fig. 4.) FAA's strategic plan, titled the Flight Plan, provides a 5-year view of the agency's goals and performance measures. Each of the agency's major organizational units, called lines of business, develops a plan that supports the Flight Plan. The Operational Evolution Plan monitors how NAS capacity will change over a rolling 10-year planning horizon depending on numerous variables, such as the demand for air travel, the completion of new runways; and the availability of new ATC systems. Ultimately, FAA plans to link the Operational Evolution Plan and the 20-year plan of the JPDO.

⁶The President's Management Agenda was issued in fiscal year 2002 as a strategy for improving the performance and management of the federal government.

Figure 4: Relationship of FAA's Plans to Department-Level and Executive Branch-Level Plans

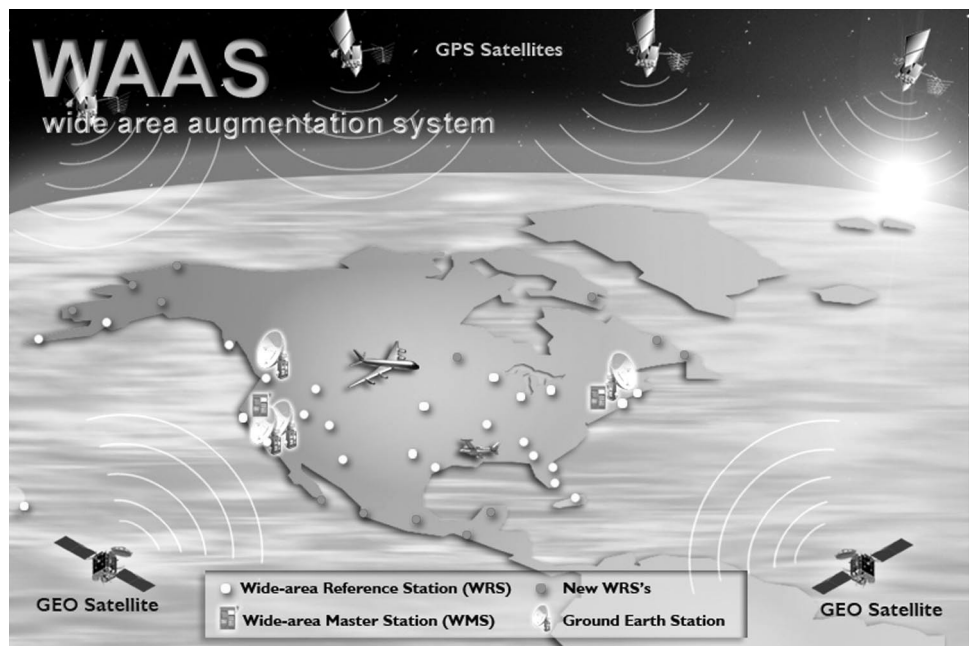


Source: FAA.

FAA Envisions a More Flexible and Efficient NAS

Satellite-based ATC systems and new digital communications systems are key elements of FAA's vision for NAS modernization. Under this vision, pilots would use performance-based navigation, which makes optimum use of an aircraft's capabilities, combined with new satellite and ground-based navigation systems and digital communications systems to use the NAS more efficiently. Properly equipped aircraft would navigate using satellite signals from the global positioning system (GPS). Because GPS alone does not produce a signal that matches the performance of existing ground-based navigation aids, FAA has deployed a Wide Area Augmentation System (WAAS), consisting of many widely spaced wide area reference stations, that provide information necessary to transmit the WAAS signal to users. (See fig. 5.) GPS and WAAS provide precise navigation and landing guidance at all airports, including the thousands that have no ground-based landing capacity. Consequently, WAAS significantly enhances navigation capabilities at these U.S. airports.

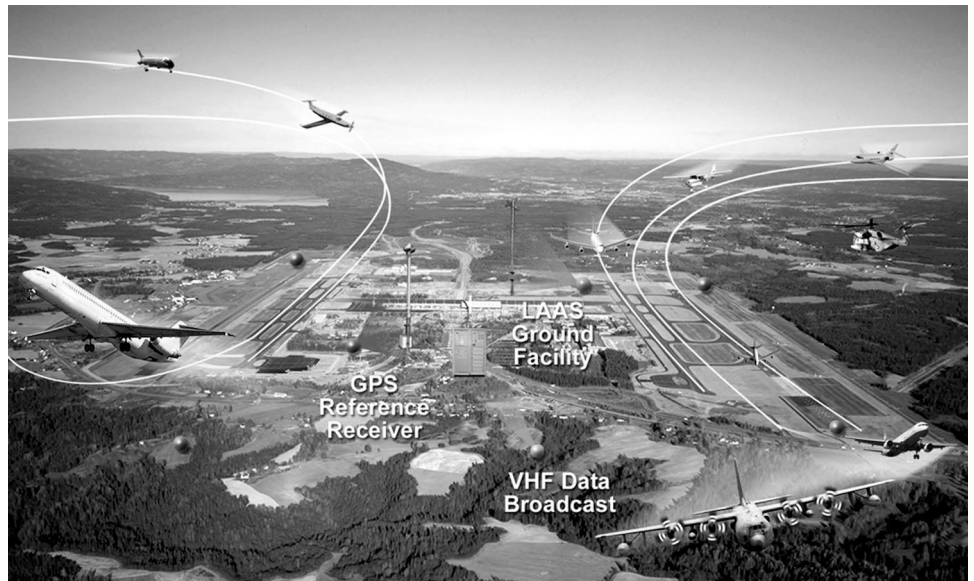
Figure 5: Wide Area Augmentation System



Source: Photo courtesy of FAA.

FAA is developing a similar system, called the Local Area Augmentation System (LAAS). (See fig. 6.) LAAS would also use GPS signals to provide more precise landing guidance at airports, but coverage would be airport-specific rather than nationwide, like WAAS's coverage. LAAS, as envisioned, would exceed the capabilities of current instrument landing systems and increase NAS capacity by providing more precise approach paths and reducing required separation between incoming aircraft in all weather conditions, as well as shorter and more flexible curved approaches to airports. WAAS and LAAS could eventually allow FAA to eliminate about half of the current ground-based system of navigational aids and instrument landing systems.

Figure 6: Local Area Augmentation System



Source: Photo courtesy of FAA.

However, WAAS and LAAS cannot fully replace ground-based navigational technologies because GPS signals are susceptible to disruptions from atmospheric effects, signal blockage from buildings, and interference from communications equipment, as well as from deliberate acts. Without a backup system, such as that provided by ground-based navigational aids, commercial operations, which are essential to the nation's economic vitality, could be interrupted. Therefore, FAA and the Department of

Defense (DOD) plan to maintain a number of ground-based navigational aids and instrument landing systems as a backup system. These aids and systems would also serve general aviation aircraft that are not equipped with satellite navigation systems. The backup system could further aid in reestablishing surveillance of an aircraft that loses satellite contact.

FAA's vision for NAS modernization also includes digital communications systems, such as that envisioned under the Controller-Pilot Data Link Communications (CPDLC) program. CPDLC would improve the efficiency of routine communications by sending structured sets of phrases between controllers and pilots in suitably equipped aircraft to eliminate the need for voice communications, thereby reducing air traffic controller workload and allowing better use of voice frequencies. The Next Generation Air-to-Ground Communication System (NEXCOM) would replace existing analog controller-pilot communication systems with a new state-of-the-art digital system. This would improve ATC communications capabilities and security by requiring a digital form of authentication, thus preventing the possibility of "phantom controllers" gaining access to the communications system.

Collecting weather data and forecasting weather conditions are joint efforts of the Department of Commerce, FAA, and DOD. Weather information is critical for NAS operators—those who control aircraft and provide flight service information to pilots, as well as NAS users—the pilots, airline dispatchers, and airport operators, among others, who use it in every facet of their operations. Weather information systems range from the automated weather data systems at airports to sophisticated forecasts of en route conditions. For example, the Alaskan Flight Services Automation System will integrate real-time weather graphics with weather and aeronautical information.⁷ The overall network of weather data collection sites, computer systems, and communications covers the entire United States.

⁷FAA has an ongoing ATC modernization effort in Alaska. This modernization effort includes software improvements for pilots' weather briefings and infrastructure improvements for flight service facilities.

Numerous Reviews of FAA's Modernization Efforts Have Identified Problems and Proposed Solutions

We have reported on the cost, schedule, and/or performance problems that FAA has encountered in NAS modernization and Congress has passed legislation to address these problems. We have issued numerous reports and made over 30 recommendations to improve FAA's ATC modernization efforts. These reports focused on many aspects of the NAS, including

- the management of modernization projects, including the use of project reviews, milestones, and baselines, and the development of cost-accounting information;
- the management of the information technology that is at the heart of many modern ATC systems, many of which could directly or indirectly increase NAS capacity;
- the challenges FAA faces in increasing NAS capacity and reducing delays;
- human capital challenges, such as the need to hire thousands of air traffic controllers in the coming decade to replace those becoming eligible to retire; and
- a workforce culture that lacked the mission focus, accountability, coordination, and adaptability needed for FAA to meet its cost, schedule, and performance targets for system acquisitions.

FAA has implemented many of these recommendations to varying degrees.

In September 1993, the National Performance Review concluded that, among other things, federal personnel rules prevented FAA from reacting quickly to the agency's needs for attracting and hiring staff. Subsequently, Congress directed the Secretary of Transportation to study the management, regulatory, and legislative reforms that would enable FAA to provide better ATC services. The Secretary of Transportation argued strongly that the agency needed flexibility to pay people what the job required and to move them where the work was needed, without the restrictions of standard government personnel procedures. FAA also maintained that it needed flexibility to deviate from the Federal Acquisition Regulations to allow it to better manage its ATC modernization program.

Congress exempted FAA from most personnel and procurement regulations in legislation passed in late 1995.⁸

In 1994, to provide more stability in FAA leadership, Congress established a 5-year term for the administrator. The first administrator to complete this 5-year term served from 1997 to 2002. In contrast, during the first 10 years of the ATC modernization effort, FAA had seven administrators and acting administrators, whose average tenure was less than 2 years.

In 1996, Congress established the National Civil Aviation Review Commission to develop, among other things, specific recommendations on how the administration could reduce costs, raise additional revenue for the support of agency operations, and accelerate modernization efforts. In 1997, the commission offered the following recommendations:

- FAA's management must become more performance based,
- FAA must control its operating costs and increase capital investments,
- airport capital needs must be met,
- FAA's revenue stream must become more cost based, and
- FAA's budget treatment must change.

In December 2000, President Clinton issued an executive order and Congress passed supporting legislation, which together gave FAA the authority to create the performance-based Air Traffic Organization (ATO) to control and improve FAA's management of the modernization effort.⁹ The executive order envisioned that the ATO would be better able to exercise the procurement and personnel authorities granted by Congress. The order directed the ATO to incorporate FAA's Research and Acquisitions and Air Traffic Services organizations—essentially those that develop and acquire systems, and those that operate them, respectively. FAA hired a chief operating officer in August 2003 to head the ATO. In February 2004,

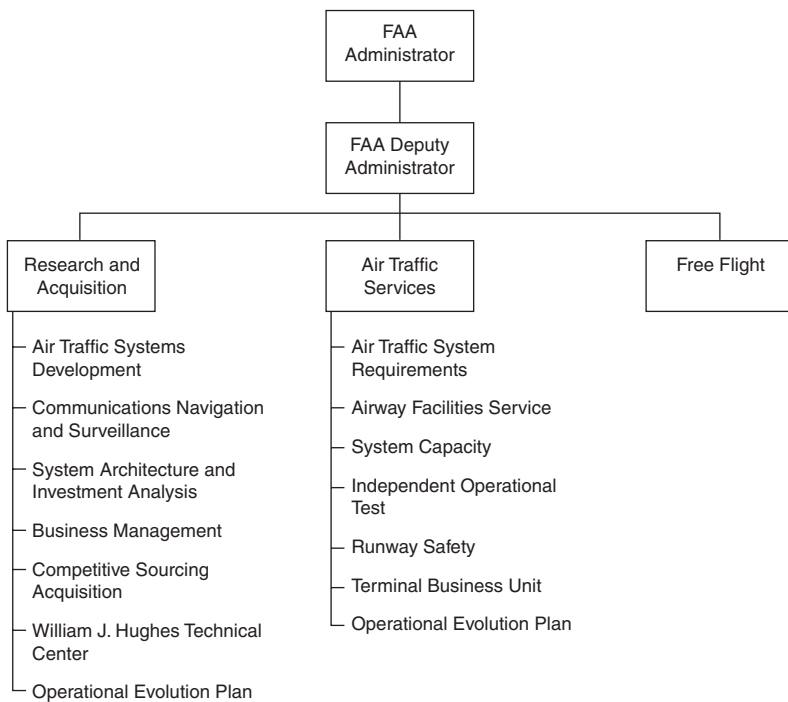
⁸P.L. 104-50, Fiscal Year 1996 Department of Transportation Appropriations Act.

⁹Executive Order 13180, which created the ATO, was amended by Executive Order 13264 in June 4, 2002, which removed the caveat that air traffic services are an "inherently governmental function."

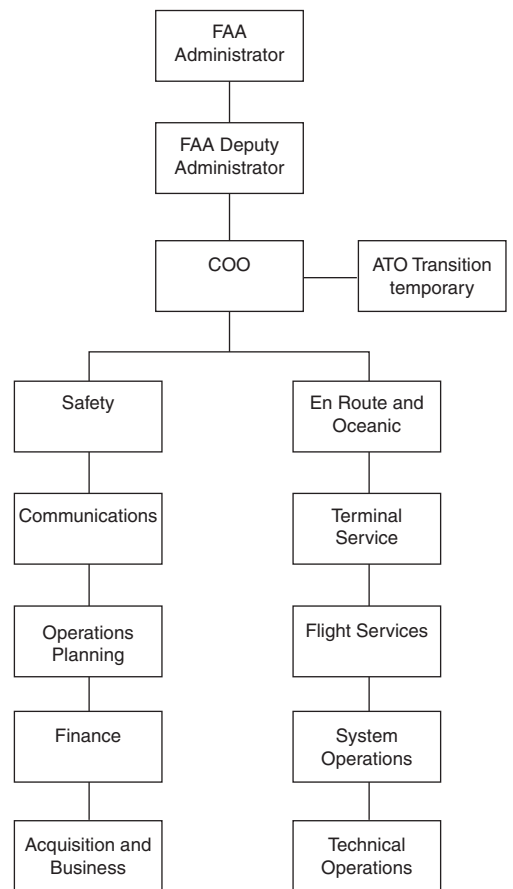
FAA reorganized, transferring 36,000 employees, most of whom worked in air traffic services and in research and acquisitions, to the ATO. (See fig. 7.)

Figure 7: Prior and Current Structure of Research and Acquisitions, Air Traffic Services, and Free Flight Organizations

Before ATO realignment



After ATO realignment



Source: FAA.

Objectives, Scope, and Methodology

We assessed the status of FAA's efforts to modernize several key components of the NAS's infrastructure: ATC systems—a major component of the NAS; information security; and NAS capacity expansion through airspace redesign and runway construction. We also addressed FAA's human capital and financial management challenges, including rising

costs and uncertain future revenues. We conducted our work from June 2004 through June 2005, in accordance with generally accepted government auditing standards.

Our methodology included summarizing recently completed work on all aspects of NAS modernization, and where necessary, updating that work and performing new evaluation work. We reviewed FAA reports on its plans for the NAS, including its Flight Plan, Operational Evolution Plan, Roadmap for Performance-Based Navigation, and Controller Staffing Plan, and reports by the Department of Transportation's Office of the Inspector General. We also reviewed relevant legislation and committee reports and drew heavily from our completed work on air traffic congestion, runway construction, acquisitions management, acquisition of software-intensive ATC systems, information technology investment management, controller staffing, acquisition workforce culture, and human capital reforms.

To broaden our perspective on NAS modernization, we assembled an international panel of experts for a day-long symposium and asked them to address the following questions:

- What factors have affected the schedule, cost, and performance of FAA's ATC modernization program, and what steps could the ATO take in the short term to address these factors?
- How have federal budget constraints affected ATC modernization, and what steps could the ATO take in the short term to address these constraints?
- What steps could FAA take in the longer term to improve the modernization program's chances of success and help the ATO achieve its mission?

We also interviewed a number of aviation stakeholders including officials at the Radio Technical Commission for Aeronautics (RTCA), DOD, the American Association of Airport Executives, the Aircraft Owner and Pilots Association, FAA's Avionics Systems Branch, the Air Transport Association, and the National Air Traffic Controllers Association.

To update previous work and obtain a clearer understanding of FAA's procedures, we met with FAA's administrator and assistant administrator for human resources management and obtained information from officials in FAA's Airports Organization. Within the ATO, we met with the chief

operating officer, the vice president for acquisitions and business services, the vice president for finance, and the JPDO director and deputy director.

As part of our effort to evaluate FAA's progress in addressing human capital management challenges, we analyzed FAA employees' responses to items on workforce culture issues that FAA included in employee attitude surveys conducted in 1997, 2000, and 2003. We selected these items with expert assistance and compared the responses to those for similar items contained in a research database on workforce culture. Appendix I contains detailed information on our methodology for analyzing and comparing survey data.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Transportation for its review and comment. In response, ATO managers; FAA's Chief Information Officer; and the Acting Director, Office of Financial Controls, provided oral comments. FAA commented that its fiscal year 2007 budget request will reflect its balancing of current and future funding priorities, and, therefore, our recommendation to this effect may be unnecessary. We are retaining this recommendation because it applies not only to fiscal year 2007, but to future years as well. Likewise, FAA managers commented that the agency is already utilizing all available financial management tools, including looking at alternative financing mechanisms. Our draft report discussed FAA's consideration of alternative financing mechanisms at length. We continue to believe that FAA should explore further opportunities to contract out its services; consolidate major facilities; and accelerate decommissioning of ground-based navigation aids, as we have noted in this report. Therefore, we are also retaining this recommendation. FAA did not comment on the remaining recommendations.

FAA also provided a number of technical comments and clarifications throughout the report, which we included as appropriate.

FAA Has Made Changes to Improve Infrastructure Management, but Acquisition, Security, and Capacity Challenges Remain

We recently reported on FAA's system acquisition, security, and capacity challenges. We reported that FAA got off to a good start in 2004 by meeting its acquisitions performance goal and has recently taken several steps to address the factors that contributed to acquisition problems in the past. However, it still faces challenges in some areas. Our recent report on information security highlights the need for FAA to ensure that key information technology systems are protected from willful acts of sabotage. Finally, we reported on the challenges that FAA faces in expanding the NAS's capacity to accommodate current and anticipated increases in air travel.

FAA Met Its 2004 Acquisitions Performance Goal

As we recently reported, FAA met its acquisitions performance goal for fiscal year 2004: to meet 80 percent of the designated milestones and maintain 80 percent of the critical program costs within 10 percent of the budget, as published in FAA's Capital Investment Plan. Having such a goal is consistent with the President's Management Agenda, which calls for a commitment to achieve immediate, concrete, and measurable results in the near term and meeting this goal indicates a good start for the ATO. While meeting this 1-year goal is a positive step toward better acquisition management, evaluating it in the context of overall acquisition achievements provides a more comprehensive assessment.¹ For example, 3 of the 16 major system acquisitions that we reviewed in detail were being revised to reflect cost and/or schedule changes during 2005. These revised cost and schedule changes would become the new milestones for the fiscal year 2006 performance goal. While revising targets that are no longer valid is an appropriate management action, using revised targets, rather than the original targets, as a basis for overall performance measurement, does not provide a consistent benchmark for measuring acquisition performance over time. Annual performance targets should continue to be viewed in the broader context of acquisitions' original and revised baselines, and in the variance reports provided to the FAA administrator and to Congress.

¹Our statements about cost, schedule, and/or performance in this and past reports are based on the original targets that FAA established and approved for each acquisition program. FAA noted that it tracks acquisition performance against original baselines and reports variances that exceed predefined thresholds to the administrator and Congress as required.

**FAA Is Addressing Key
Factors That
Contributed to Legacy
Cost, Schedule, and/or
Performance
Problems, but More
Work Remains**

We recently reported that, historically, four factors individually or collectively contributed to system acquisitions' missing cost, schedule, and/or performance targets.² FAA is taking steps to address some of these factors, but needs to do more.

**Four Key Factors
Contributed to Legacy Cost,
Schedule, and/or
Performance Problems**

One or more of four factors—(1) funding acquisitions at lower levels than called for in agency planning documents, (2) adding requirements and/or unplanned work, (3) underestimating the complexity of software development, and (4) not sufficiently involving stakeholders throughout system development—contributed to 12 of 16 major acquisitions' missing targets.³ (See table 2.) Appendix II provides each system's full name and purpose.

²[GAO-05-331](#).

³See [GAO-05-331](#). We reviewed the 16 ATC system acquisitions with the largest life-cycle costs that met the following criteria: each system had cost, schedule, and/or performance targets; each system was discussed in prior GAO and Department of Transportation Inspector General reports, had not been fully implemented or deployed by 2004, and received funding in 2004. We reviewed this list with FAA officials to ensure that we did not exclude any significant system. In fiscal year 2005, these 16 major ATC system acquisitions account for about 36 percent of FAA's capital budget.

Chapter 2
**FAA Has Made Changes to Improve
 Infrastructure Management, but Acquisition,
 Security, and Capacity Challenges Remain**

Table 2: Four Key Interrelated Factors Contributing to Cost Growth, Schedule Extensions, and/or Performance Shortfalls for 12 ATC System Acquisitions

Name of system	The funding level received was less than the agency planning documents	The system acquisition experienced requirements growth and/or unplanned work	The complexity of software development was underestimated	Stakeholders were not sufficiently involved
ASDE-X ^a	X	X	X	
ASR-11	X	X		
ATCBI-6	X			
CPDLC		X		
FFP2	X			
ITWS	X	X	X	
LAAS		X	X	X
NEXCOM	X	X		
NIMS-2	X	X		
OASIS	X	X		X
STARS		X		X
WAAS		X	X	X

Source: GAO analysis of FAA data.

Notes:

Blank spaces in the chart denote that the specific factor was not a key contributor to a program's inability to meet cost, schedule, or performance targets.

FAA's Telecommunications Infrastructure, another of the 16 system acquisitions that we reviewed, also experienced cost growth, but for a reason not shown above. The original planning document that was prepared for this acquisition contained estimated costs for some of the system's requirements. When the planning document was updated, it included actual contract costs, which were greater than originally estimated.

^aAdditional factors are listed, beyond those previously reported, based on updated information provided by FAA.

A discussion of each factor follows:

- *Funding acquisitions at lower levels than called for in agency planning documents:* When FAA initiates a major system acquisition, it estimates, and its top management approves, the funding plans for each year. However, when budget constraints do not allow all system acquisitions to be fully funded at the previously approved levels, FAA must decide which programs to fund and which to cut, according to its priorities. When a system acquisition does not receive the annual funding called for in its planning documents, the acquisition may fall behind schedule. This may also postpone the benefits of the new system

for the NAS, and can require FAA to continue operating and maintaining the older equipment that the acquisition is intended to replace.

- *Adding requirements and/or unplanned work:* Inadequate or poorly defined requirements may contribute to the inability of system acquisitions to meet their original cost, schedule, and/or performance targets, since developing or redefining requirements as an acquisition progresses takes time and can be costly. In addition, unplanned development work may occur when the agency misjudges the extent to which a commercial-off-the-shelf or nondevelopmental item,⁴ such as one procured by another agency, will meet FAA's needs.
- *Underestimating the complexity of software development:* When FAA underestimates the complexity of software development or misjudges the difficulty of modifying available software to fulfill its mission needs, acquisitions may take longer and cost more than expected.⁵
- *Not sufficiently involving stakeholders throughout system development:* Not involving relevant stakeholders, such as air traffic controllers and maintenance technicians, early and throughout a system's development and approval may lead to costly changes in requirements and unplanned work late in the development process.

In some cases, FAA missed cost, schedule, and/or performance targets because of two or more of the factors discussed above. For example, FAA underestimated the complexity of the software that would be needed to support WAAS when the agency reduced, by 3 years, its plans to develop, test, and commission the system. FAA then tried to accomplish these tasks in 28 months, even though the software development alone was originally expected to take from 24 to 28 months. FAA's efforts to resolve this issue resulted in unplanned work, which then contributed to cost increases and

⁴FAA defines a commercial-off-the-shelf item as a product or service that has been developed for sale, lease, or license to the general public. The product is currently available at a fair market value. FAA defines a nondevelopmental item as an item that was previously developed for use by a government (federal, state, local, or foreign) and that requires limited further development. For example, an Army radio is the core of FAA's NEXCOM radio, and the software that FAA selected for its new oceanic ATC system was a nondevelopmental item from New Zealand's air system.

⁵For purposes of this report, the underestimation of software complexity refers to poor estimation of the level of effort that would be required to modify software to meet requirements (e.g., commercial-off-the-shelf or nondevelopmental items).

schedule delays. For STARS, not adequately including stakeholders during the development phase contributed to unplanned work, which in turn, contributed to cost growth, schedule delays, and eventually a reduction in the number of systems to be deployed.

The remaining three systems that we reviewed—En Route Automation Modernization System (ERAM), Advanced Technologies and Oceanic Procedures (ATOP), and En Route Communications Gateway (ECG)—are meeting cost, schedule, and performance targets, but warrant close attention. ERAM, the new computer system to help run FAA's en route ATC operations, is a high-risk effort, in part because it requires over 1 million lines of code. While ERAM's contractor has completed the first three of four software deliveries ahead of schedule, "bugs" could be discovered through further testing and integration, which could require additional software development, according to a senior program official. In the past, FAA has had difficulty developing systems with such a high volume of code. Also, FAA assumed responsibility after February 2005 for the cost of resolving any additional software problems that it identifies with ATOP, its new oceanic ATC system. A fixed-price contract previously governed the acquisition. FAA also anticipates adding requirements costing about \$500,000 to ECG, a communications interface.

FAA Has Taken Steps to
Improve Acquisition
Management, but Has Not
Fully Implemented Some
Recommendations

FAA has announced plans to implement recommendations we made to improve software-intensive acquisitions and investment management practices.⁶ However, FAA has not yet adopted a knowledge-based approach for system acquisitions or fully implemented our recommendations to improve its enterprise architecture development.

To reduce the risk of requirements growth and/or unplanned work, as well as the risks associated with acquiring software-intensive systems, FAA has developed and applied a process improvement model to a number of acquisition projects. This model is used to assess the maturity of FAA's software and systems capabilities. As we reported, this approach has resulted in enhanced productivity, higher quality, greater ability to predict

⁶As required by 31 U.S.C. 720, the Department of Transportation submitted a written statement of the actions taken on our recommendations to the Senate Committee on Homeland Security and Governmental Affairs and to the House Committee on Government Reform. We have not yet evaluated whether these actions fully address our recommendations.

schedules and resources, better morale, and improved communication and teamwork.⁷ However, because FAA did not mandate the use of the model throughout the organization, we recommended that it do so. In response, FAA has begun developing a requirement that projects have process improvement activities in place before seeking approval from the FAA investment review board.

FAA told us in December 2004 that it is taking actions that respond to our recommendations for improvements to its Acquisition Management System.⁸ For example, FAA reports that when reviewing acquisitions, it now focuses on the acquisition's impact on customer service and contribution to achieving the agency's strategic and performance goals, including expanding NAS capacity, rather than on the approval and management of individual acquisition programs. FAA has also informed us that it has established basic investment management capabilities, including many practices for selecting and controlling its mission-critical information technology investments. Our previous work showed that FAA was not regularly reviewing investments that are more than 2 years into their operations. As a result, FAA was limited in its ability to oversee, as a total package of competing investment options, more than \$1 billion of its information technology investments, and to pursue only those that best meet its goals.⁹ In its response to our recommendation, FAA stated that it had changed its acquisition review process to a semiannual "service level review" process that encompasses systems that are in service. Additionally, FAA has changed its format for justifying major technology investments to that prescribed by the Office of Management and Budget. According to FAA, this change provides more comprehensive information than the previous format and provides efficiencies by avoiding the need to later translate the information into the Office of Management and Budget's prescribed format. We have not yet assessed these actions.

Additionally, further improvements to FAA's Acquisition Management System are warranted. We recently reported that while the system provides some discipline for acquiring major ATC systems, it does not apply a

⁷GAO-04-901.

⁸GAO, *Air Traffic Control: FAA's Acquisition Management Has Improved, but Policies and Oversight Need Strengthening to Help Ensure Results*, GAO-05-23 (Washington, D.C.: Nov. 12, 2004).

⁹GAO-04-822.

knowledge-based approach to acquisitions that is characteristic of commercial best practices. Such practices call for specific knowledge to be captured and used by corporate-level decision-makers to determine whether a product has reached a level of development (product maturity) sufficient to demonstrate its readiness to move forward in the acquisition process. Knowledge is captured at specific junctures, or knowledge points, in the acquisition cycle, which developers use to determine whether they have attained the knowledge they need to move to the next phase or activity in the acquisition process. Such developers also conduct corporate executive-level reviews to ensure that they obtain the insights and perspectives of stakeholders throughout their organization. If the knowledge attained does not meet the criteria for advancement or if the executive reviewers determine that further development is inconsistent with their priorities, the acquisition does not move forward.

Experience with these best practices has shown that to the extent that the level of knowledge called for at each knowledge point is not attained, organizations take on risks in the form of unknowns that will persist into the later stages of development, where they will take more time and money to resolve if they become problems. Such problems lead to cost increases and schedule delays. Accordingly, we recommended that FAA (1) develop explicit written criteria for the key decision points called for under best practices, including the capture of specific design and manufacturing knowledge, and (2) require corporate executive-level decisions at these key decision points (before an acquisition moves from integration to demonstration and, again, before it moves to production).¹⁰

We also reported that FAA has taken some initial steps to develop a NAS enterprise architecture, but further steps are needed.¹¹ An enterprise architecture serves as a blueprint to guide and constrain investments in a consistent, coordinated, and integrated fashion. It should provide a clear and comprehensive picture of an organization, including snapshots of the current “as is” environment as well as the target “to be” environment, and a roadmap for transition. FAA has committed resources to this effort, established a project office, designated a chief architect, and issued the latest version of its architecture. However, FAA has not taken some key steps, such as designating a committee or group representing the

¹⁰GAO-05-23.

¹¹GAO-05-266.

enterprise to direct, oversee, or approve the architecture; establishing a policy for developing, maintaining, and implementing the architecture; or fully developing architecture products that meet contemporary guidance and describe both the “as is” and the “to be” environments and developed a sequencing plan for transitioning between the two. Our experience with federal agencies has shown that making information technology investments without defining these investments in the context of an architecture often results in systems that are duplicative, not well integrated, and unnecessarily costly to maintain and interface.

FAA Faces Challenges in Ensuring Information Security

Because ATC systems rely heavily on information technology, protecting them from inadvertent or intentional disruption is critically important. The risks to information systems include the escalating threat of computer security incidents, the ease of obtaining and using hacking tools, the steady advance in the sophistication and effectiveness of attack technology, and the emergence of new and more destructive attacks. Inadequately protected systems are at risk of intrusion by individuals or groups with malicious intent, who could use their unauthorized access to obtain sensitive information, disrupt operations, or launch attacks against other computer systems and networks. A prolonged disruption in ATC systems and communications, accidental or intentional, could disrupt air traffic, cause significant economic losses, and subject travelers to delays and inconvenience. Federal information security has been on GAO’s list of high-risk areas since 1997; in 2003, GAO expanded this high-risk area to include the protection of cyber-critical infrastructure.¹²

Recently, we reported that FAA had established, but not fully implemented, an information security program for its ATC information systems.¹³ For example, some of the agency’s security plans were outdated; security awareness training requirements were not fully met; system testing and evaluation programs were inadequate; security incident detection capabilities were limited; and shortcomings existed in providing service continuity to protect against disruptions in operations. Furthermore, we identified security weaknesses that threaten the integrity, confidentiality, and availability of the three critical systems we reviewed, including weaknesses in controls designed to manage access to these systems.

¹²GAO-05-207.

¹³GAO-05-712.

Weaknesses in physical security increase the risk that unauthorized individuals could gain access to sensitive computing resources and data and could inadvertently or deliberately misuse or destroy them. In response to weaknesses that we had identified, FAA officials told us they recognized that more work was needed to continue to improve their information security program and that they had already corrected many of their electronic access control weaknesses.

We recommended several actions intended to improve FAA's information security program. FAA agreed to consider our recommendations, but emphasized that, because our review focused on only three systems, it does not indicate that the entire NAS is vulnerable. Additionally, FAA maintains that vulnerabilities are mitigated by redundancies and separate access controls. Consequently, FAA concluded that the public may infer from our review that security risks are higher than they actually may be. In our report, we acknowledged that FAA may have other protections built into its overall system architecture. However, as noted in the report, the complex air traffic control system relies on several interconnected systems. As a result, the weaknesses we identified may increase the risk to other systems. For example, FAA did not consistently configure network services and devices securely to prevent unauthorized access to and ensure the integrity of computer systems operating on its networks.

FAA Faces Challenges in Expanding NAS Capacity to Meet Current and Future Needs

The current level of air travel, combined with airlines' use of smaller aircraft, is straining NAS capacity and further increases in air travel are forecast. FAA has developed a rolling 10-year plan for capacity improvements at the nation's 35 busiest airports, and airports are building new runways. However, many congested airports are not building or cannot build new runways, and delays at these airports can have ripple effects throughout the NAS. FAA is considering administrative and market-based options to ease congestion at the most delay-prone airports. The agency is also redesigning flight procedures in specific locations to improve the efficiency with which aircraft use crowded airspace. However, FAA has encountered difficulties in establishing reliable costs and schedules for its airspace redesign efforts, and airlines have been reluctant to equip their aircraft because of uncertainty about FAA's future plans for airspace redesign.

More Travelers and Smaller Aircraft Could Strain NAS Capacity

In 2004, passengers returned to air travel, following a lull that resulted from a series of largely unforeseen events, including global recessions, the terrorist attacks of September 11, and the Severe Acute Respiratory Syndrome (SARS) scare, the war in Iraq, and associated security concerns. Enplanements in 2004 exceeded those in 2000 by 5 percent. The high level of traffic in the summer of 2000 produced the worst record of delays up to that time; however, nearly as many delays occurred in 2004, but the delays were longer, on average, mainly because of bad weather, according to FAA officials. FAA forecasts a 25-percent increase in air traffic by 2015, and the JPDO is developing plans to transform the NAS to accommodate a tripling of capacity by 2025.

The airlines' increasing use of smaller aircraft is likely to enhance the need for capacity. In 2001, we reported that the growing number of regional jets, which generally seat fewer than 100 passengers, was contributing to congestion in our national airspace.¹⁴ The industry experts we interviewed repeatedly expressed concern about the impact of additional aircraft on airspace whose capacity was already strained. Because hundreds of new aircraft have been added to already congested airspace while comparatively few aircraft have been taken out of service, many experts believe that increasing congestion and delays are inevitable. Moreover, the experts noted that with many more regional jets on order, congestion and delays are not likely to diminish in the near future. In 2003, Boeing forecast that regional jets would account for 16 percent of the world aircraft fleet by 2022. In June 2004, the Chairman and Chief Executive Officer of AirTran Airways noted that the ATC system could have difficulty absorbing the hundreds of regional jets then on order.¹⁵ Recent data validate those concerns. Although passenger travel between 2000 and 2004 increased by 5 percent, the number of aircraft operating in the NAS, as indicated by domestic aircraft departures, increased by 36 percent during that time period.

Additionally, air taxis, which carry about four passengers each, could begin operations within the NAS. FAA officials told us that they have been briefed

¹⁴GAO, *Aviation Competition: Regional Jet Service Yet to Reach Many Small Communities*, [GAO-01-344](#) (Washington, D.C.: Feb. 14, 2001).

¹⁵Testimony of Joseph Leonard, Chairman and Chief Executive Officer of AirTran Airways before the Subcommittee on Aviation, House Committee on Transportation and Infrastructure, June 3, 2004.

on proposals for using air taxis in selected metropolitan areas to relieve heavy traffic congestion on roadways. Air taxis could add to air congestion, as well as increase the workload of air traffic controllers in metropolitan areas where air traffic is already likely to be heavy. Potential increases in general aviation could further increase air congestion and controllers' workload.¹⁶

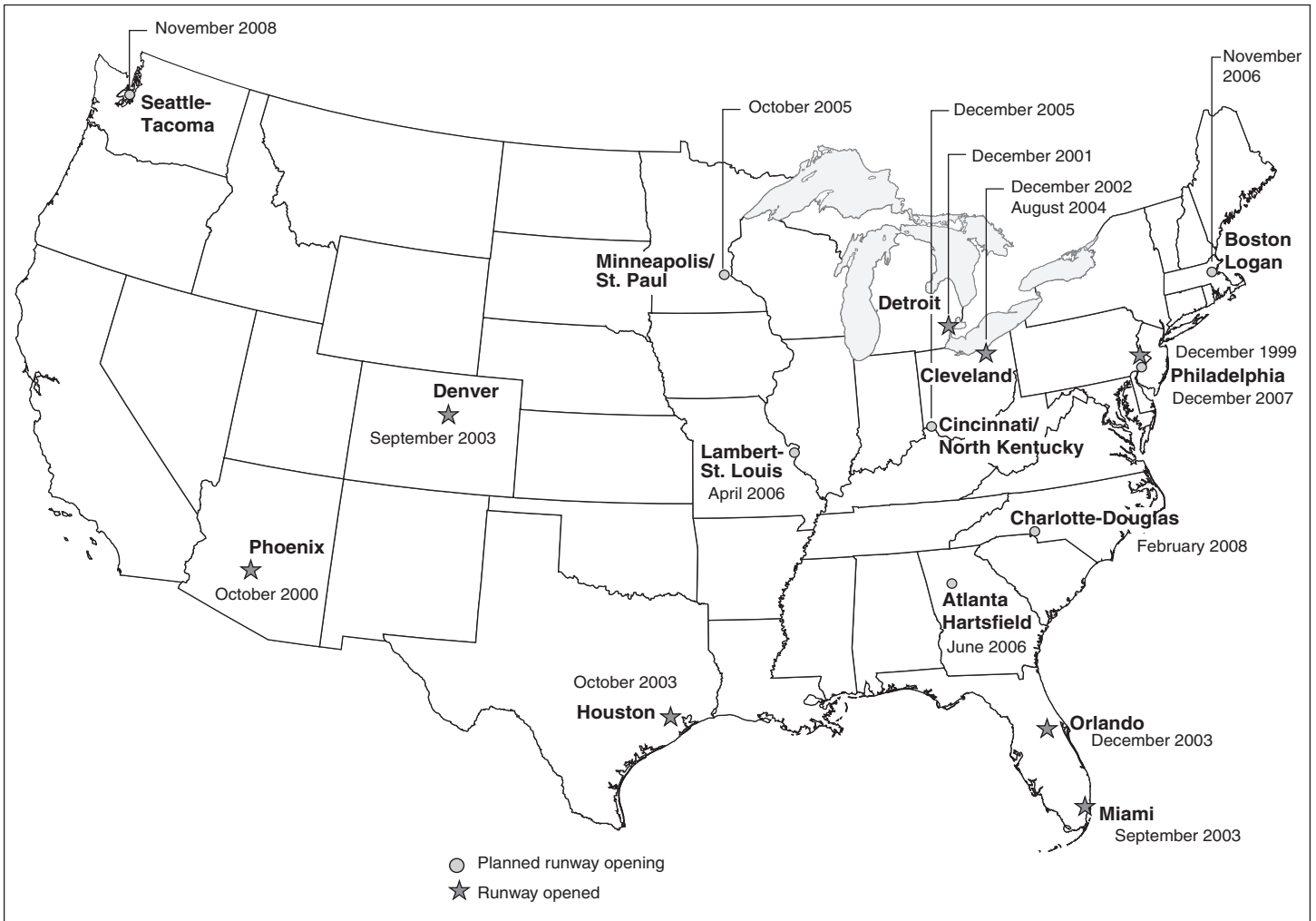
New Runways Are Under Construction and More Are Planned to Increase NAS Capacity

According to FAA, building new runways is the most direct approach to increasing NAS capacity. FAA estimates that a new runway increases an airport's capacity by between 30 and 60 percent. FAA's plans for capacity enhancement at the nation's 35 busiest airports are laid out in the agency's rolling 10-year Operational Evolution Plan. Since 1999, 8 of the nation's 35 busiest airports—Phoenix, Detroit, Denver, Miami, Cleveland, Houston, Philadelphia, and Orlando—have each opened a new runway. Collectively, these runways have provided these airports with the potential to accommodate about 1 million more annual operations (takeoffs and landings). Six more runways, one runway extension, and one airfield reconfiguration are scheduled to open by the end of 2008 at the nation's 35 busiest airports. These runways are expected to provide those airports with the potential to accommodate 830,000 more annual operations. (see fig. 8). In addition to the runways scheduled for the 35 busiest airports, nine more capacity-enhancing projects are in the planning or environmental review stages, including one new runway, three runway extensions, three new airports and two airfield reconfigurations in major metropolitan areas.

¹⁶General aviation includes a wide variety of aircraft, ranging from corporate jets to small piston-engine aircraft as well as helicopters, gliders, and aircraft used in operations such as firefighting and agricultural spraying.

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Figure 8: Commissioned and Planned Runways, December 1999 to November 2008



Source: GAO analysis of FAA data, and Map Art.

Note: Included in the planned runways is one runway extension project at Philadelphia.

Several of the nation's largest airports are among those most in need of capacity improvements. In a recent study, FAA reported that the Atlanta, Newark, New York LaGuardia, Chicago O'Hare, and Philadelphia airports needed immediate capacity improvements to meet existing demand. The study identified 15 airports that would need capacity improvements by 2013.

However, building new runways is not an option at all airports with pressing needs for more capacity. Some airports are not able to build even one more runway, either because they lack the space or would face intense opposition from adjacent communities. Only 3 of the 9 most delay-prone airports will receive new runways, and delays at these airports can have a ripple effect throughout the NAS, notwithstanding capacity improvements made elsewhere. For example, in 2000, Phoenix Sky Harbor International Airport put an additional runway into service, and the airport had sufficient capacity to allow flights to take off on time. However, the airport ranked among the top 15 in the United States for flight delays. According to airport officials, most of the delays in Phoenix were the result of delays and cancellations at other airports—circumstances unrelated to the capacity at Phoenix. To reduce flight delays at some of the delay-prone airports, such as New York LaGuardia and Chicago O’Hare, FAA is exploring administrative and market-based options. For example, FAA is considering auctioning off landing and takeoff rights at New York LaGuardia and is currently limiting the number of scheduled arrivals during peak periods at New York LaGuardia and Chicago O’Hare.

FAA Is Redesigning Flight Paths to Create More Capacity

FAA is redesigning how aircraft utilize airspace during the takeoff, landing, and en route phases of flight. Currently, most aircraft must follow established routes over designated navigation aids and maintain wide separation from other aircraft. Wide separation has been necessary to provide a margin of error against inaccuracies in older navigation systems. However, many aircraft in use today carry navigation equipment that is not dependent on ground-based navigation aids and would enable aircraft to safely operate in a less restrictive manner, allowing more efficient use of airspace and increased NAS capacity.¹⁷ Moreover, this equipment provides aircrews with precise information on the location of their aircraft and that of nearby aircraft, allowing them to fly more directly to their destinations, thereby saving time and fuel, and reducing congestion. Advanced

¹⁷FAA has established “Area Navigation,” commonly known as RNAV, which allows properly equipped aircraft to navigate using onboard systems in conjunction with satellites or ground-based navigation aids to fly desired flight paths without requiring direct flight over ground-based navigation aids. RNAV provides for more direct routing, avoiding suboptimal routes prescribed by conventional “highways in the sky” that are defined by point-to-point flying over ground-based navigation aids. The RNAV concept and a major new method for exploiting it, called required navigation performance (RNP), permit flight in any airspace as long as aircraft have been certified to meet the required accuracy level for navigation performance.

navigation capabilities also reduce the adverse impact of bad weather on NAS efficiency by allowing pilots to land in weather conditions that they otherwise would have to avoid.

In 2005, FAA increased airspace capacity by reducing the required minimum vertical separation from 2,000 feet to 1,000 feet for properly equipped aircraft at altitudes between 29,000 and 41,000 feet, essentially doubling capacity at those altitudes. FAA anticipates that this change will allow aircraft to safely fly the most efficient routes, increase airspace capacity, and save airlines about \$400 million in fuel costs during the first year.

FAA reports that airspace redesign can provide benefits at a number of airports. For example, at Dulles International Airport, suitably equipped aircraft could simultaneously depart on parallel routes in bad weather, which would not otherwise be possible. Dallas-Fort Worth International Airport could increase capacity by 20 percent by allowing aircraft with the appropriate capabilities to depart more quickly from multiple points at the airport, thereby reducing the taxi time between terminal and departure, as well as ground congestion. According to FAA, allowing aircraft with appropriate equipment to use parallel runways during periods of marginal visibility could increase arrival rates by 10 to 24 percent at airports with closely spaced runways, such as those in Boston, Cleveland, Newark, Portland, Philadelphia, Seattle, and San Francisco.¹⁸ An FAA official told us that these procedures could leverage the future benefits of ATC systems currently in the acquisitions pipeline if planned and implemented in coordination with the systems' acquisition schedules.

Redesign is a complex process that requires the development of specific navigation procedures tailored to each location, taking into account numerous factors. According to FAA, the following factors pose challenges for redesign efforts:

- costly environmental reviews required by the National Environmental Policy Act,
- the logistics of coordinating meetings with controllers and operators to discuss how to design the procedures,

¹⁸Marginal weather conditions occur between 5 and 20 percent of the time at these airports.

- aircrew training,
- the modeling and testing of procedures, and
- the development of written navigation and air traffic control procedures.

Consequently, FAA focuses its efforts on airports that are the best candidates to benefit from airspace redesign, such as those that have frequent bad weather, parallel runways that cannot be used for parallel approaches in bad weather, nearby mountains or tall buildings, or aircraft noise that adversely affects nearby communities. Also, having an airline that has a significant presence at an airport and is willing to take the lead in airspace redesign facilitates its implementation.

Airspace Redesign Efforts Have Encountered Cost and Schedule Challenges, and Airlines Are Hesitant to Invest in Advanced Capabilities

The Department of Transportation's Office of the Inspector General has testified that FAA is experiencing significant problems in its airspace redesign efforts. The office reported that FAA lacks reliable information on costs and schedules for 42 airspace redesign efforts and found that FAA's process for controlling costs, mitigating risks, and coordinating these efforts was fragmented and diffuse.

Expanding efforts to redesign airspace also depends on the willingness of NAS users to equip their aircraft with advanced capabilities—a willingness that is based, in part, on the belief that FAA will continue with its redesign plans. Some stakeholders we interviewed expressed concern that FAA may not follow through with its airspace redesign efforts. For example, a DOD official said that in response to budget constraints, FAA might curtail its airspace redesign efforts after DOD had equipped its aircraft with advanced capabilities, resulting in a waste of DOD resources. The official cited FAA's actions to suspend certain acquisition programs such as LAAS, NEXCOM, and long-range radar. An official of the Airline Owners and Pilots Association, which represents general aviation pilots, cited similar concerns with WAAS and another system (Automatic Dependent Surveillance – Broadcast) in onboard navigation systems. Consequently, general aviation pilots are hesitant to invest in systems for their aircraft unless they are sure that FAA will continue to redesign airspace and implement procedures that will make use of this equipment. According to one expert, some aircraft have been retired without ever having their advanced capabilities used.

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Overcoming these challenges is a productive area of focus for FAA. Our panel of experts noted that exploiting airspace redesign is a “quick hit” that would produce good value for the investment, and airlines are anxious to see more airspace redesign efforts. The experts also noted that the private sector has the capacity to develop new flight procedures as part of airspace redesign, and a precedent exists in another country. However, the experts said that in the past, FAA has resisted outside parties’ efforts to design new flight procedures for FAA’s approval, and they suggested that FAA could be more flexible in this area.

Agency Comments

FAA provided technical comments, which we included as appropriate.

Human Capital Management Challenges Include Hiring Air Traffic Controllers and Transforming FAA's Organizational Culture

During the coming decade, FAA will need to hire and train thousands of air traffic controllers to replace those who will retire. FAA has implemented a number of human capital reforms but still faces the challenge of transforming its workforce to a more results-oriented culture.

FAA Will Need to Hire and Train Thousands of Controllers in the Next Decade

In 2002 and 2004, we reported that FAA would need to hire and train thousands of air traffic controllers during the next decade, and we recommended in 2002 that FAA develop a comprehensive workforce plan that includes strategies to ensure that FAA would have adequate human resources and training facilities to meet its hiring needs while maintaining safety.¹ Additionally, we recently reported that succession planning and management are critical steps that federal agencies need to take to meet the challenges of the 21st Century.² In 2004, FAA published a controller staffing plan that includes several of the strategies that we recommended. Recognizing that the plan would be costly, FAA planned to obtain savings from a number of human capital management initiatives, some of which will require union negotiation.

Impending Retirements Will Require Extensive Hiring and Training

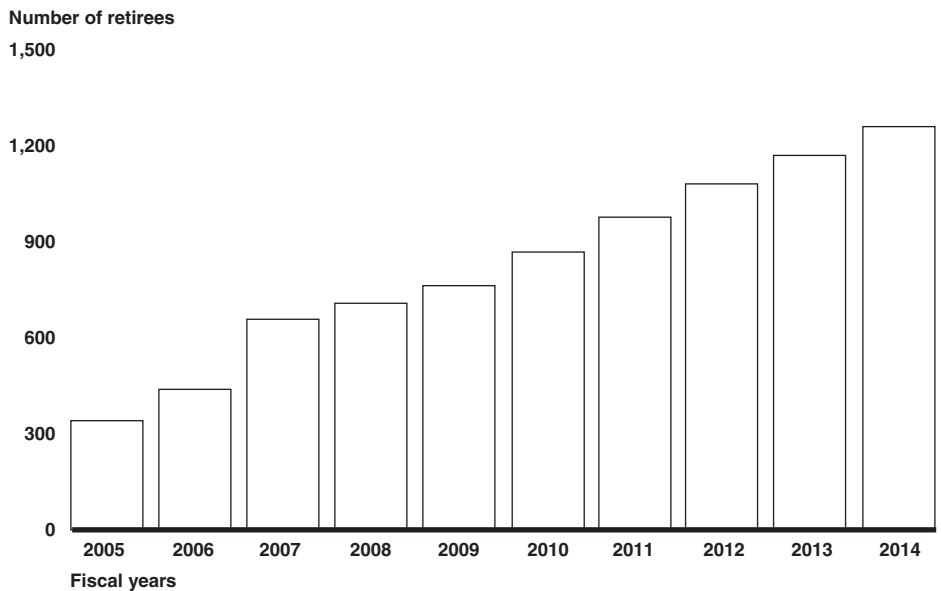
FAA's controller staffing plan indicates that the agency expects to lose about 11,000 air traffic controllers, or about 73 percent of the controller workforce, to retirements and other factors.³ This high percentage of retirements is attributable to the 1981 controller strike, when President Ronald Reagan fired over 10,000 air traffic controllers, and the consequent need to quickly rebuild the controller workforce. From 1982 through 1991, FAA hired an average of 2,655 controllers per year. These controllers will become eligible for retirement during the next decade. (See fig. 9.)

¹GAO-02-591; GAO, *Federal Aviation Administration: Plan Still Needed to Meet Challenges to Effectively Manage Air Traffic Controller Workforce*, [GAO-04-887T](#) (Washington, D.C.: June 15, 2004).

²GAO, *Human Capital: Selected Agencies Have Opportunities to Enhance Existing Succession Planning and Management Efforts*, [GAO-05-585](#) (Washington, D.C.: June 30, 2005); and *21st Century Challenges: Reexamining the Base of the Federal Government*, [GAO-05-325SP](#) (Washington, D.C.: February 2005).

³FAA, *A Plan for the Future: The Federal Aviation Administration's 10-Year Strategy for the Air Traffic Control Workforce* (Dec. 21, 2004).

Figure 9: Projected Controller Retirements, Fiscal Years 2005 - 2014



Source: FAA.

To replace the controllers who will retire, as well as those who will leave for other reasons, and to accommodate forecasted increases in air traffic, FAA plans to hire a total of 12,500 new controllers over the next 10 years, or 1,250 per year, on average. Because of training facility limitations and the need to minimize the impact on operational facilities of on-the-job training for new controllers, FAA plans to hire relatively equal numbers of controllers each year.

FAA's Controller Staffing Plan Reflects Lessons Learned Since 1981 Controller Strike

To manage the air traffic control workforce over the next decade, the controller staffing plan that lays out a 10-year strategy for recruiting, hiring, and training new controllers to replace those that retire. This plan, which we recommended in a 2002 report and Congress mandated in 2003, reflects recruiting and training lessons learned since the 1981 air traffic controllers' strike, endeavors to benefit from the expertise of today's experienced controllers, and addresses staffing and equipment needs at FAA's training academy.

According to the controller staffing plan, FAA has established a facility-by-facility retirement loss model that FAA will use to determine annual hiring

targets for each facility. The plan also lays out a strategy to develop new staffing standards for each ATC facility, starting in fiscal year 2005. Additionally, the plan describes a revised hiring policy, which recognizes the need to hire replacement controllers well in advance of expected retirements, rather than waiting until after each controller leaves.

FAA's plan lays out new recruitment sources designed to identify and retain viable candidates. Through this approach, FAA expects to achieve greater success than it did in the 1980s, when it last hired large numbers of controllers but had problems with retention. At that time, FAA officials told us, most of the candidates were recruited "off the street," with no prior background in air traffic control. According to the plan, over 40 percent of the candidates failed training, resulting in wasted training funds. This time, FAA plans to hire new controllers from a variety of sources, including some that can provide candidates with training or experience in aviation. A primary source will be the Air Traffic Collegiate Training Initiative, which FAA established in January 1991 and has since expanded.⁴ Under this initiative, participating schools produce candidates with college degrees and a broad knowledge of the aviation industry. These candidates have at least a basic level of training in air traffic control and have demonstrated their interest in the field by the investment they have made in their own training. Other potential recruits include former and retired military personnel, former Professional Air Traffic Controllers Organization controllers, and the general public.

FAA is also evaluating the effectiveness of a tool to screen potential controllers. Between 1981 and 1992, FAA screened out unsuccessful candidates over a period of 9 weeks as they attended a formal training program. Fewer than 60 percent of the candidates passed the screen. Recognizing that this was a costly process, FAA dismantled the 9-week screening process in 1992 and implemented an 8-hour computer-based Air Traffic Selection and Training exam to screen candidates, reducing the screening cost from \$10,000 per candidate to \$800 per candidate. The screening exam evaluates many aptitudes, including prioritization and problem solving, decisiveness, and composure. The controller staffing plan indicates that FAA's Civil Aerospace Medical Institute is evaluating the effectiveness of this new screening tool, as we recommended.

⁴Because FAA's intake of new controllers was very low from 1994 until recently, the agency did not need to seek candidates from other sources.

FAA believes that allowing some controllers to continue working beyond the current age limitation could help alleviate staffing shortages in targeted locations. Under legislation enacted in 1971,⁵ most controllers are required to stop handling live traffic when they reach age 56. FAA has reviewed the safety implications of waiving this requirement under certain circumstances. Specifically, its Civil Aerospace Medical Institute reviewed the scientific basis for the law and concluded that the scientific literature did not provide a firm foundation for either retaining the age 56 limit or seeking a legislative change. A supplemental study found that the likelihood of an en route operational error declined with age as a function of experience. According to the controller staffing plan, FAA believes that waivers to the age 56 rule may be of value for targeted locations where there may be a critical staffing shortage. FAA estimates that 5 to 10 percent of current controllers might be granted such waivers.

The controller staffing plan describes FAA's plans to address staffing and equipment needs at the training academy. FAA plans to meet the need for more instructors by working with its contractor to ensure that training needs are met. FAA has also upgraded equipment at the training academy. We reported in 2002 that equipment used at the academy to train en route controllers did not match equipment used in the field. We also reported that tower simulators were often broken or outdated, and lacked the necessary capacity to train large numbers of new hires. FAA has since acquired four new tower simulators, and in the spring of 2005, it opened a laboratory for en route training at the academy, several months ahead of schedule.

FAA Plans Cost-Saving Initiatives to Mitigate the Expense of the Controller Staffing Plan

Recognizing the immense cost of recruiting and training enough controllers to replace those who are retiring, FAA plans to implement efficiencies that would reduce training costs and allow a 10 percent reduction in the controller workforce over the next decade. FAA plans to provide more intensive training so that controllers can be certified in 2 to 3 years, rather than 4 to 5 years as in the past. Some of these initiatives will require union consent which FAA will have to negotiate when it renews its contract with the controllers. For example, FAA plans to rely on part-time employees and job-sharing arrangements, as well as implement split shifts, where all controllers work during peak periods, but some leave during slack periods and return to complete their shifts later. FAA also plans to improve its

⁵P.L. 92-297.

management of overtime by using the optimal mix of increased staffing and overtime hours to meet workload demands. In addition, FAA plans to oversee the use of sick leave more aggressively and to manage workers' compensation cases to bring employees back to duty as quickly as possible. Other steps include reducing the number of hours controllers spend on union-related duties and in workgroups, conferences, and meetings; and employing efficiencies made possible by implementing technological advances, consolidating facilities, and expanding the contract tower program.

FAA has neither determined the total cost of the controller staffing plan, nor developed any basis for the cost savings planned for many of the initiatives described in the plan. For example, FAA officials told us that they have not determined

- the costs of hiring and training controllers from different sources;
- the amount of productivity savings from various sources, including implementing new technology and adjusting staffing according to traffic levels; or
- the savings from the improved training success rate.

Therefore, the impact of this plan on future funding needs is unclear. FAA officials indicated that they view the plan as fluid, and will make yearly updates and changes as they move forward with its implementation. However, without supportable estimates of the hiring and training program's cost and potential savings, FAA lacks key information needed to plan for future funding needs. The plan states that if FAA does not receive sufficient funds to hire adequate numbers of controllers, FAA will maintain safety before addressing delays. According to the plan, FAA would slow air traffic to a level that the available controllers could handle safely, an action that could create significant delays in the NAS.

FAA has also begun considering whether graduates of its Air Traffic Collegiate Training Initiative can bypass the currently required training at the FAA Academy—a change that could produce savings. Currently, graduates must attend the academy for 37 days if they are training to be terminal controllers or 57 days if they are training to be en route controllers, before they can report to an ATC facility to begin on-the-job training. The National Air Traffic Controllers Association and one of the colleges that participates in the Air Traffic Collegiate Training Initiative

believe that graduates could bypass the training academy and report directly to an ATC facility to begin on-the-job training. In June 2005, FAA initiated a review to determine whether graduates could bypass the academy training.

FAA Has Made Progress in Implementing Human Capital Reforms, but Challenges Remain in Transforming Its Workforce Culture

Since receiving an exemption from many federal personnel management regulations in 1995, FAA has implemented a number of compensation, hiring, and performance management reforms. Additionally, FAA is taking steps toward developing a results-oriented culture, but needs to ensure continuity and follow-through for these efforts to have a lasting effect.

FAA Has Implemented Elements of Personnel Management Reform

After being exempted from most federal personnel regulations in 1995, FAA initiated a broad set of changes in compensation, performance management, and workforce management. FAA replaced the general schedule system of 15 pay grades—each with 10 within-grade pay steps—with a series of pay bands and specific job categories with minimum and maximum pay rates spanning two to five pay bands. Since 2003, when we last reported on the status of FAA's human capital reforms, FAA has increased the percentage of the workforce covered by the new pay system from about 75 percent to 82 percent.⁶

Additionally, FAA established its own hiring policies and began hiring applicants directly, rather than going through the Office of Personnel Management. It also established a flexible system for adjusting the number of executive positions in response to shifting agency priorities and set up flexible policies for determining whether and how much to reimburse employees' relocation expenses.

Finally, FAA established a new performance management system, which it uses for 45 percent of its employees. The new system requires that

⁶GAO, *Human Capital Management: FAA's Reform Effort Requires a More Strategic Approach*, [GAO-03-156](#) (Washington, D.C.: Feb. 3, 2003).

employees have performance plans that identify specific work expectations and outcomes and are linked to agency and organizational goals. The new system changed performance assessment from a once-a-year process to one that focuses on interim feedback discussions between employees and supervisors to address performance issues when they arise, and identify opportunities for improving performance and meeting developmental needs. The performance management system also determines whether an employee is eligible for agencywide performance-based bonuses. FAA has not yet included most of its bargaining unit employees under the new performance management system, but plans to negotiate this issue during contract negotiations, which began in the spring of 2005.

While we have not evaluated the merits of the new performance management system or that used to manage the performance of bargaining unit employees, linking work expectations and outcomes to organizational goals, as FAA has done in its new performance management system, is a positive first step. We have reported that effective performance management systems are not merely used for once or twice-yearly individual expectation setting and rating processes, but are tools to help the organization manage on a day-to-day basis. These systems are used to achieve results, accelerate change, and facilitate two-way communication throughout the year so that discussions about individual and organizational performance are integrated and ongoing.⁷

Developing a Results-Oriented Organizational Culture Remains a Key Challenge

Recognizing the importance of cultural change in achieving results, FAA is moving forward on actions consistent with those that we have identified as important for cultural transformation. In 1996, we reported that FAA's acquisition workforce culture lacked a commitment to mission focus, accountability, adaptability, and coordination, which impeded its ATC modernization efforts. While FAA took a number of actions over the past several years to change the culture of its acquisition workforce, these actions lacked continued management commitment. Our work shows that successfully implementing cultural change requires continued management attention over several years.

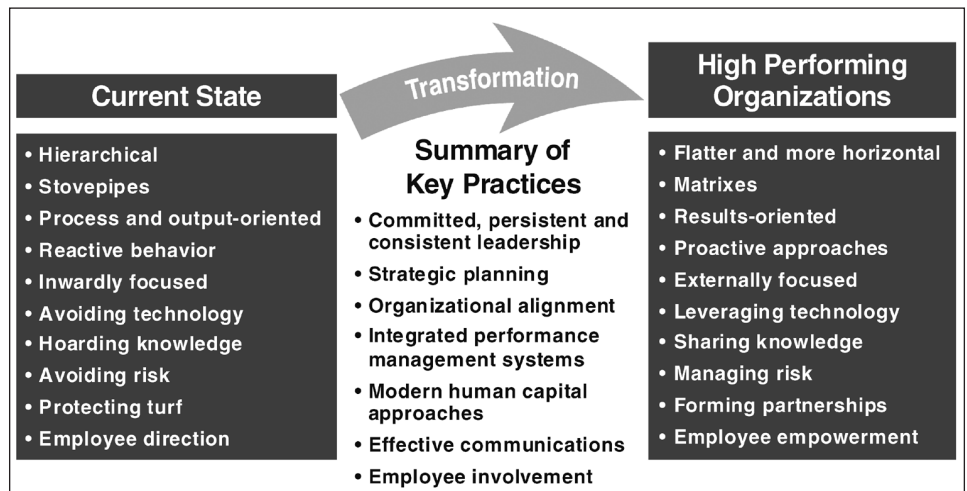
⁷GAO, *Results-Oriented Cultures: Creating a Clear Linkage between Individual Performance and Organizational Success*, GAO-03-488 (Washington, D.C.: Mar. 14, 2003).

FAA Recognizes the Importance of a Results-Oriented Culture

FAA has established a goal to create a results-oriented culture and is developing baseline data for tracking progress. FAA's Human Capital Plan includes a goal to create a results-based performance culture and strategies for implementing performance management and compensation systems that focus on achieving results, providing training and briefings on the agency's new performance management system, and implementing a communication plan for performance management responsibilities. Additionally, FAA's performance-based compensation system provides most employees with a bonus when the agency meets its performance goals.

FAA's emphasis on performance management is an important step toward creating a results-oriented culture in the acquisition workforce. Our work has highlighted the importance of organizational culture in implementing mergers and transformations. Using a performance management system to define responsibility and ensure accountability for change is a key practice that can help agencies transform their cultures so that they can be more results oriented, customer focused, and collaborative.⁸ (See fig 10.)

Figure 10: Cultural Changes and Key Practices Necessary for Successful Transformation



Source: GAO.

⁸GAO, *21st Century Challenges: Transforming Government to Meet Current and Emerging Challenges*, GAO-05-830T (Washington, D.C.: July 13, 2005).

The chief operating officer, who heads the ATO, has also recognized that cultural factors can play a critical role in an organization's success and is aiming to make a transformation similar to that shown above. For example, he has observed that FAA's management culture has been "intensely hierarchical, risk averse," and "reactionary," and aims to develop a viable, stable, and sustainable organization that can make fact-based decisions that transcend changes in leadership. He said that FAA is giving high priority to changing its leadership model by linking top management more closely to operations in the field and by replacing command and control with communication across organizational levels.

To further support cultural change, FAA is emphasizing accountability and other core values. For example, it is holding managers accountable for managing their budgets. Additionally, FAA has chosen five core values and plans to use employees' responses to selected questions in the most recent employee attitude survey⁹ to set a baseline for cultural improvement. The five core values are (1) integrity and honesty, (2) accountability and responsibility, (3) commitment to excellence, (4) commitment to people, and (5) fiscal responsibility. FAA's Civil Aerospace Medical Institute analyzed the survey results by grouping three to seven survey items under each of these areas. For example, FAA placed the survey item "We are encouraged to express our concerns openly" along with four other items under the integrity and honesty core value. For many items, across all core values, fewer than 40 percent of ATO employees indicated agreement or strong agreement, indicating that FAA still has work to do to create a culture where these core values are readily evident to the majority of its employees. FAA is addressing these items by developing its own action plan, and documenting best practices for items where positive response rates—the total percentage of agree and strongly agree—are above 55 percent.

The FAA's recognition of the importance of creating a results-oriented culture is an important step, particularly within the ATO, which is composed of formerly separate organizations. We have reported that many mergers or transformations fail because the cultures of the originating components are not fully understood or considered.¹⁰ Thus, identifying

⁹Although this survey was administered in September 2003, before the ATO was formed, FAA organized the responses according to the former suborganizations that became part of the ATO.

¹⁰GAO-03-669.

cultural features of the originating components, prior to, or early on, in the merger and transformation process, can help leadership gain a better understanding of their beliefs and values. Organizationwide surveys, employee focus groups, and individual interviews can be used to assess culture in order to provide a better understanding of how work gets done and what values are important to employees.

Past Cultural Change Efforts Met with Limited Success

Since we identified the acquisition workforce culture as an underlying cause of FAA's chronic system acquisition problems in 1996,¹¹ FAA has taken a number of steps to change its culture, but long-term management attention and focus have been lacking. Our 1996 report showed that FAA's acquisitions were impaired because the employees and managers acted in ways that did not reflect a strong commitment to mission focus, accountability, adaptability, and coordination—the key factors that we identified at that time as being associated with a constructive culture. These factors are similar to the characteristics of the results-oriented culture that FAA is seeking to develop. A results-oriented culture is also an organizational element that we have identified as key in transforming the government to meet the management challenges of the 21st Century.

In 1996 we reported that agency officials performed little or no mission needs analysis, made unrealistic cost and schedule estimates, and proceeded into the production phase of systems before completing their systems' development. We also reported that accountability was not well defined or enforced for decisions on requirements and oversight of contracts. Additionally, ineffective coordination that resulted from, among other things, stovepipe lines of authority, impaired communications between organizations that needed to coordinate, particularly between the acquisition and operations sides of FAA. Finally, we reported that FAA's culture of conservatism and conformity discouraged innovation and, instead, rewarded employees for simply following the rules.

FAA responded to our 1996 report in several ways. As we recommended, FAA developed a strategy to implement cultural change. While the strategy called for, among other things, a report on the primary impediments to cultural change and a detailed action plan, the strategy was not implemented exactly as FAA anticipated. For example, FAA laid out a series of tasks over the course of a year, including developing a communications plan, conducting focus groups, and encouraging

¹¹GAO/RCED-96-159.

workforce participation. However, according to FAA, the communications plan was never implemented because of a shift in senior leadership and organizational dynamics.

Rather than implementing the strategy for cultural change, FAA took a number of alternative actions aimed at changing the culture. For example, FAA developed an intellectual capital investment plan that outlined corporate investment priorities for workforce development. FAA also implemented a results-based individual performance management program that showed the relationship between individual performance plans and the agency's goals. Finally, FAA hired consultants to assess the acquisition workforce culture in 1998 and 2000 and developed action plans to address the issues that the assessments identified. According to an FAA official, FAA started implementing these action plans, but suspended them when the ATO was established. Additionally, although FAA strongly emphasized cultural change in the annual performance plans developed in the late 1990s, the emphasis tapered off from 2000 through 2002.

Some Recent FAA Survey Results Suggest Less Improvement in Workforce Culture Than in Prior Years

Improvements in some culture-related responses in FAA's employee attitude survey have tapered off, compared with prior years. Since 1984, FAA has periodically conducted employee attitude surveys, most recently in 1997, 2000, and 2003.¹² The survey gathers information on employees' attitudes, perceptions, and opinions about a broad variety of organizational issues. Many of the survey items relate to mission focus, accountability, coordination, and adaptability—the four characteristics of a constructive culture that we identified in 1996.

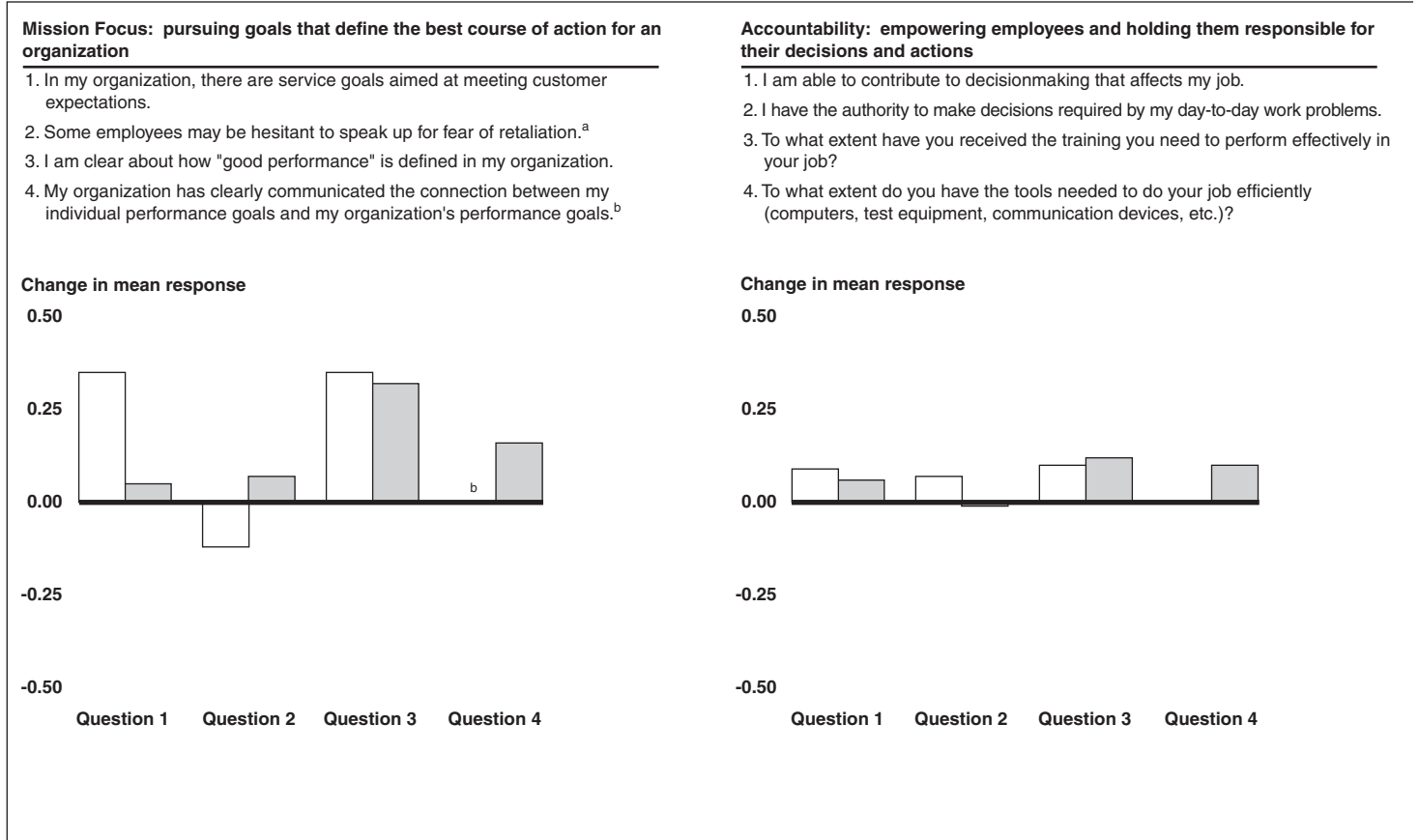
According to our analysis of employee responses to survey items, FAA made some initial progress between 1997 and 2000, but progress leveled off for many items thereafter.¹³ (See fig. 11.)

¹²See appendix I for additional information on these surveys.

¹³The surveys elicited information in a variety of ways. For example, in some cases, questions were asked and the response choices ranged from "to a limited extent" to "a great extent." In other cases statements were presented and response choices ranged from "strongly disagree" to "strongly agree." On a five-point scale, the most negative response is scored "1" and the most positive response is scored "5." Mean scores were developed by summing the responses to each question and dividing by the number of respondents. For example, a mean score of 3 for a particular question would indicate that the average response was "neither agree nor disagree," while a mean score of 4 would indicate the average response was "agree."

Chapter 3
Human Capital Management Challenges
Include Hiring Air Traffic Controllers and
Transforming FAA's Organizational Culture

Figure 11: Changes in Mean Response Scores for Selected Items on FAA's Employee Attitude Surveys, 1997 to 2000, and 2000 to 2003, for the Acquisition Workforce

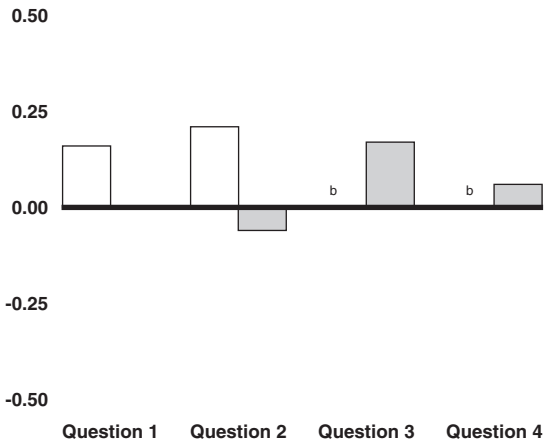


**Chapter 3
Human Capital Management Challenges
Include Hiring Air Traffic Controllers and
Transforming FAA's Organizational Culture**

Coordination: involving other employees in decisions affecting them, resolving differences collaboratively, and cooperating across organizational lines

1. Conflicts and differences in my organization are brought out and managed rather than avoided or worked around.
2. Overall, how satisfied are you with your workgroup?
3. In my organization, we are encouraged to share information to get the job done.^b
4. I trust my coworkers.^b

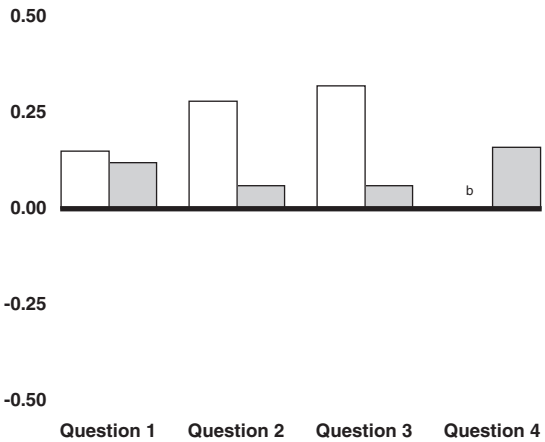
Change in mean response



Adaptability: accepting new approaches and responding positively to demands and opportunities posed from within and outside of the organization

1. To what extent has FAA done a good job creating an environment where all employees get the chance to fully contribute to organization's mission?
2. To what extent do you receive sufficient information from FAA to understand how major innovations and changes might affect you?
3. My supervisor is effective in providing periodic coaching to improve my performance.
4. To what extent has FAA done a good job creating an environment where all employees have the opportunity to participate in developmental activities (e.g., details, training, task forces, special assignments)?^b

Change in mean response



Source: GAO analysis of FAA data.

Note: FAA score estimates have 95 percent confidence intervals of plus or minus 0.06 or less. Year-to-year differences in scores of 0.08 or more are significant at the 95 percent confidence level.

^aThis question is negatively worded, such that "strongly agree," would be a negative response. For consistency, we reversed the scoring for this question, so that a "strongly agree" response would be scored 1, and a "strongly disagree" response would be scored 5. The practice of reverse scoring negatively worded items is a commonly accepted professional practice in survey research methodology.

^bNot asked in the 1997 survey.

FAA's Survey Results Are Lower
Than Those for Other
Organizations on Similar Culture
and Climate Surveys

Surveys of organizational culture in other organizations, conducted over the past 20 years (comparison group), show higher mean scores than those for FAA's acquisition workforce. To determine how FAA's culture compares with that of other organizations, we contracted with an expert in organizational culture. With this expert's assistance, we compared FAA's scores for the survey items listed in figure 10 with the comparison group's responses to similar items.¹⁴ While an exact match in the wording of survey items was not possible, we found that the mean scores for FAA's acquisition workforce were lower than those of the comparison group for 14 out of 16 items that we compared. The exceptions were for items that addressed the adequacy of training provided to perform one's job and the sufficiency of tools and equipment needed to do one's job efficiently. Appendix III lists the 16 items that we compared and the respective mean scores of FAA's acquisition workforce and of the comparison group. Appendix III also shows the mean scores for organizations with highly effective cultures, which could be used as a target towards which other organizations, such as FAA, could work to redirect their cultures and improve their performance.¹⁵

It is important to note that comparisons of the responses to questions, whose wording is similar, but not identical, are difficult because even subtle changes in a question's wording can result in different outcomes. Our expert commented that FAA's survey results are more indicative of an organization's climate, rather than culture. The expert noted, however, that research shows that climate is strongly related to culture. Therefore, we present the two sets of survey results here because the concepts that they are measuring are, in our opinion, similar enough to warrant a general comparison. Additionally, we noted in 1996 that the culture of FAA's 2,000-employee acquisition workforce needed improvement, and that the rate of initial improvement has not been sustained. Additionally, as previously stated, FAA has demonstrated its recognition of the need for a results-

¹⁴See appendix II for additional information on our methodology for assessing FAA's workforce culture.

¹⁵In November 2003, GAO hosted a forum to discuss the characteristics of high-performing organizations. The forum participants agreed that the key characteristics and capabilities of high-performing organizations can be grouped into four themes: (1) a clear, well-articulated, and compelling mission; (2) focus on needs of clients and customers; (3) strategic management of people; and (4) strategic use of partnerships. See GAO, *High-Performing Organizations: Metrics, Means, and Mechanisms for Achieving High Performance in the 21st Century Public Management Environment*, [GAO-04-343SP](#) (Washington, D.C.: February 2004).

oriented culture by creating a goal to create such a culture in its Human Capital Plan. The chief operating officer has also observed the need to change the culture of the ATO's 36,000 employees.

Transforming organizational cultures requires substantial management attention. The experiences of successful transformations and change management initiatives in large public and private organizations suggest that it can take 5 to 7 years or more until such initiatives are fully implemented and cultures are transformed in a sustainable manner. Such changes require focused, full-time attention from senior leadership and a dedicated team. The team must have vested authority and resources from top management to set priorities, make timely decisions, and move quickly to implement decisions. Such a team provides a visible signal that the transition is being undertaken with the utmost seriousness and commitment. Having a dedicated transition team is just one of several practices that we have identified, such as setting implementation goals and a timeline and establishing a communication strategy, that are key to successful mergers and organizational transformations. (See app. IV for a complete list.)

Conclusions

FAA has addressed a number of the challenges it faces in hiring and training thousands of air traffic controllers over the coming decade. However, FAA's lack of information on the cost of this program is of particular concern as the agency enters a period of anticipated lean budgets, as discussed in the next chapter. A shortage of funds that results in hiring fewer controllers than needed could lead to additional delays in air travel, beyond those caused by infrastructure constraints.

Successful organizational transformations and cultural changes require several years of focused attention from senior leadership. In the past, FAA set, but did not sustain, a fact-based course for creating a constructive organizational culture. Promising initiatives, such as detailed action plans, were developed but not implemented or sustained, and without continued attention to cultural change from the top, improvements leveled off, and FAA now appears to lag behind other organizations on cultural measures. FAA's current effort to establish a baseline for measuring cultural change represents an important first step, but additional steps and sustained management attention will be needed to achieve and maintain progress. Unless FAA succeeds in transforming itself into an organization that is more mission focused, accountable, cooperative, and adaptable, it could have difficulty establishing the results-oriented culture that it seeks.

Recommendation for Executive Action

To provide Congress with accurate information on the resources needed to hire and train thousands of air traffic controllers over the next decade, we recommend that the Secretary of Transportation direct the FAA Administrator to estimate the cost of FAA's controller hiring and training plan and incorporate these estimates into future budget requests.

To ensure that FAA provides the long-term focus needed for an effective cultural transformation, we recommend that the Secretary of Transportation direct the FAA Administrator to provide sustained oversight of efforts to transform FAA's workforce culture to one that is more results-oriented, including periodically monitoring the agency's progress against baseline data.

Agency Comments

FAA did not comment these recommendations, but provided technical comments which we included as appropriate.

Rising Costs and Declining Revenues Pose Financial Management Challenges

FAA faces the dual challenge of rising costs and declining revenues, culminating in a projected multibillion-dollar gap between its expected budget targets and expected spending requirements through fiscal year 2009. To attempt to live within its means, FAA is cutting programs and controlling costs, but these steps will not come close to closing the gap. FAA officials and some experts and stakeholders believe a key element in addressing the agency's financial management challenges is changing FAA's revenue structure from the present ticket-tax-based structure to one more closely tied to FAA's cost of providing services. Collectively, aviation experts and stakeholders suggested that FAA could address its financial management challenges through a two-pronged approach: in the near term, consider options that are readily available, such as contracting out more of its services and pursuing other cost-saving measures; and over the longer term, determine whether a business case could be developed to support more extensive changes that would require presidential and/or congressional action to implement, such as providing the ATO with more financial management flexibility.

To Address Rising Costs and Declining Revenues, FAA Is Focusing on Cost Control

FAA is concerned about the impact of rising costs and reduced budget targets through fiscal year 2009, combined with uncertainty over future balances in the Trust Fund.¹ FAA is attempting to live within its reduced means by controlling its costs.

FAA Projects a Multibillion-Dollar Gap

FAA projects an \$8.2 billion gap between its expected budget targets and expected spending requirements through fiscal year 2009. Under existing budget targets set through fiscal year 2009, FAA would receive about 17 percent less each year in capital funding than it received in fiscal years 2002, 2003, and 2004. For fiscal year 2005, FAA received an appropriation of \$2.5 billion for capital expenditures, and capital budget targets for fiscal

¹The Office of Management and Budget reviews each executive branch agency's input to the budget that the President submits to Congress each February. The budget includes the most recently completed year, the current year, the budget year, and at least the four following years, called outyears. The Office of Management and Budget informs agencies of its decisions on the budget through its "passback." In this report we refer to the outyear budgets shown in the passback as budget targets.

years 2006 through 2009 are just under \$2.5 billion. In contrast, for fiscal years 2002 through 2004, FAA received annual capital appropriations of nearly \$3 billion. (See fig. 12.)

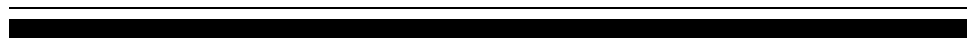
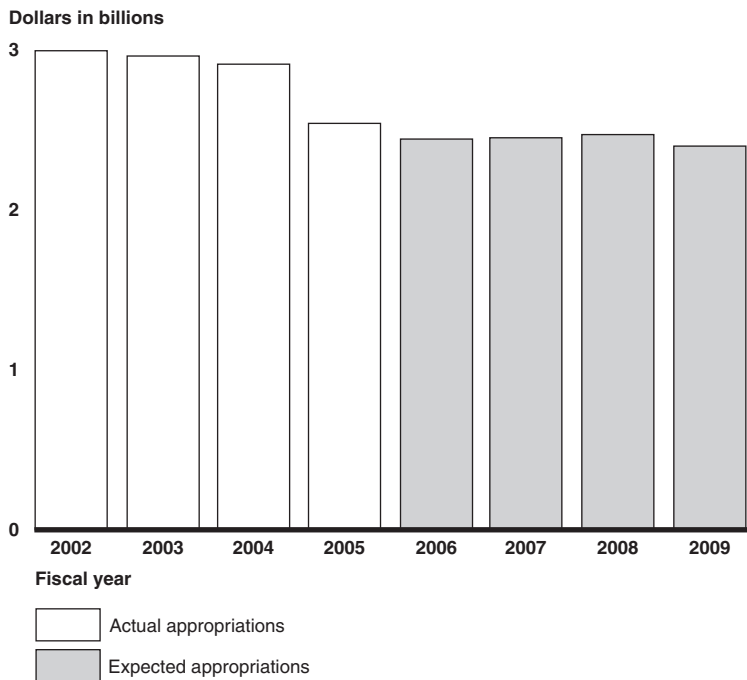


Figure 12: Actual Capital Appropriations, Fiscal Years 2002 – 2005, and Budget Targets, Fiscal Years 2006 – 2009

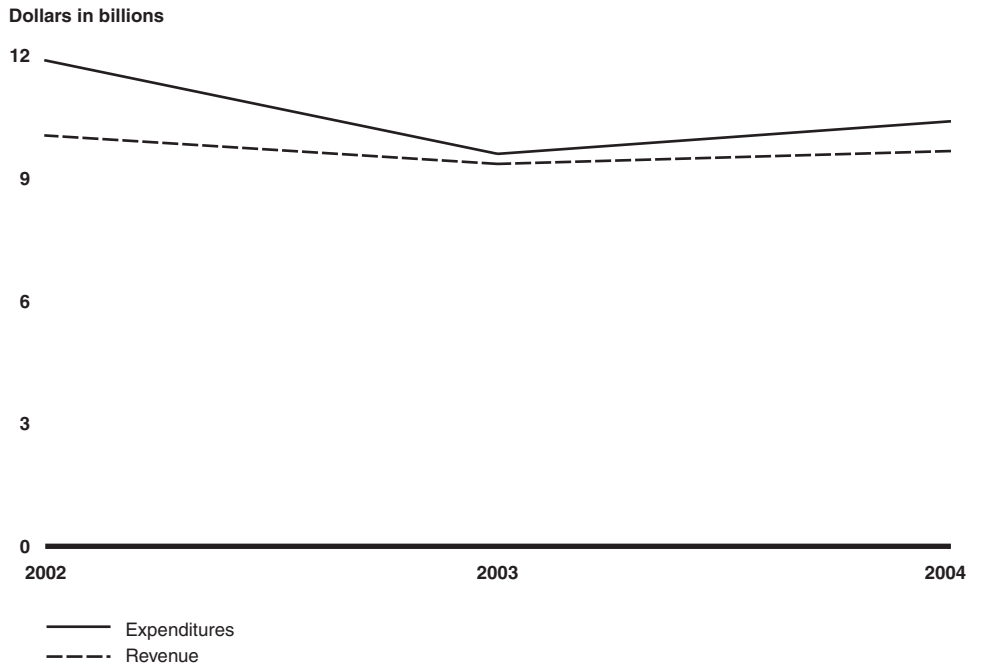


Source: GAO analysis of FAA data.

Compounding FAA's financial concerns is ongoing uncertainty over revenue forecasts for the Trust Fund. From fiscal years 2002 through 2004, FAA's expenditures declined at a steeper rate than the Trust Fund revenues, but the expenditures nonetheless remained higher. (See fig. 13.) Although revenues increased from fiscal years 2003 through 2004, expenditures increased more rapidly.

Chapter 4
Rising Costs and Declining Revenues Pose
Financial Management Challenges

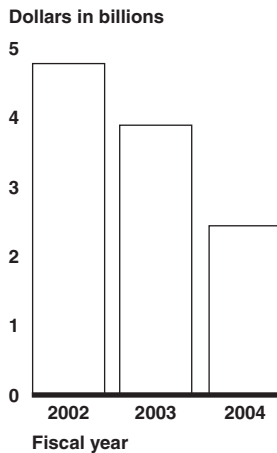
Figure 13: Aviation and Airway Trust Fund Expenditures and Revenues, Fiscal Years 2002 - 2004



Source: GAO analysis of FAA data.

The combined effect of the higher expenditures and the lower revenues is a reduction in the Trust Fund's uncommitted balance of nearly 50 percent from fiscal years 2002 through 2004. (See fig. 14.)

Figure 14: Aviation and Airway Trust Fund Uncommitted Balances, Fiscal Years 2002 - 2004



Source: GAO analysis of FAA data.

We recently testified that in 4 out of the last 5 years, actual trust fund revenues fell short of forecasts. Our analysis indicated that if revenues fall 10 percent short of forecasts for fiscal years 2005 through 2007, the fund could be bankrupt by 2006.²

FAA Cut Major Programs and the ATO Is Gathering and Tracking Data to Control Costs

FAA cut funding for three major programs. For fiscal year 2005, the appropriation for FAA's facilities and equipment budget, which funds ATC system acquisitions, was \$393 million less than the agency had planned to spend. FAA conducted an intensive review of its capital investment portfolio and absorbed the \$393 million reduction largely by suspending the funding for CPDLC, an e-mail-like messaging system for communications between air traffic controllers and pilots; eliminating a major component of NEXCOM, an air-to-ground digital communications system; and returning LAAS, a precision landing system augmented by satellites, to research and development to resolve a key performance shortfall.

The ATO plans to manage its services on the basis of costs. Key to this effort is FAA's implementation of a cost accounting system. Until recently,

²GAO, *Airport and Airway Trust Fund: Preliminary Observations on Past, Present, and Future*, [GAO-05-657T](#) (Washington, D.C.: May 4, 2005).

FAA had no cost accounting system and could not accurately determine the cost of its activities. When fully implemented in 2006, the cost accounting system should address our long-standing concern that FAA lacked the cost information necessary for decision making as well as to adequately account for its activities and major projects, such as the air traffic control modernization program. Additionally, the ATO intends to use the cost accounting system to provide more credible and transparent analyses of the costs and benefits of alternative plans of action. For example, ATO officials said the system will enhance their ability to accurately determine the costs of providing specific services or products, and to compare those costs with the value provided to the organization's customers. This information will be valuable in prioritizing activities and weighing the costs and benefits of various courses of action when developing and supporting proposed budgets.

The ATO also plans to hold its managers accountable for cost control. The ATO has decentralized cost accountability to service delivery points—the units that actually provide services—such as air traffic control facilities. Each manager of a service delivery point will develop an operating budget. According to the ATO's plans, each manager will be held accountable for holding costs within specific targets. Managers will track their costs using reports that show expenditures for operations, facilities and equipment, and overhead, as well as cost per service. For example, managers will receive reports indicating the cost per takeoff and landing, or cost per flight hour, depending on the organizational unit's purpose. ATO officials stressed that training key executives and managers to understand the general ledger and cost accounting system is a key element in controlling costs. The ATO plans incorporate cost control into the performance rating and bonus system in fiscal year 2006.

FAA has also begun to base funding decisions for system acquisitions on their contribution to reducing the agency's operating costs, among other things. Currently, FAA's Telecommunications Infrastructure—one of the 16 major system acquisitions that we reviewed in detail—is the only one of the 55 system acquisitions in FAA's ATC modernization program that helps reduce the agency's operating costs. However, FAA does not expect to realize most of these benefits until after 2009.

The ATO is conducting activity value analysis as another method to reduce costs. Through activity value analysis, the ATO determines (1) the costs of the products and services provided, (2) the factors that affect the costs, and (3) the value of these products and services, as perceived by the ATO's

internal customers. Through activity value analysis, officials are asking the internal organizations that use the ATO's products and services to categorize their value as high, medium, or low, while ATO officials categorize the cost of performing each activity as high, medium, or low. ATO officials expect the process to help them eliminate activities with low customer value and determine ways to reduce the costs of activities with high customer value.

The ATO first focused the activity value analysis on headquarters units, and plans to do so later at field units. The results of the headquarters analysis indicated that internal customers rated only 5 out of 73 reviewed products or services as low value, and all of these were also low cost. Officials judgmentally selected 11 activities for a more in-depth analysis to determine areas for potential improvement. The activity value analysis resulted in 39 discrete findings and recommendations with common themes. (See table 3.)

Table 3: Common Themes and Number of Findings from ATO's Headquarters Activity Value Analysis

Common theme	Number of findings
Accountability or metrics is needed	19
Tools and systems lack standardization	18
Approach across service units is inconsistent	15
Process is too complex or disparate	9
Function or organization is too spread out	9
Process is sound, but not enforced; may require minor adjustments	3
Product or service is an afterthought	3

Source: FAA.

Existing Cost Control
Initiatives Will Not Close the
Projected Gap

FAA, through the ATO, has a number of cost control initiatives under way. For example, the ATO is evaluating whether some of its services can be provided for less cost by contracting out. In February 2005, FAA awarded a contract for the operation of its flight service stations. Under this arrangement, which FAA termed the largest competitive sourcing activity, at that time, in the federal government, the agency expects significant savings. According to FAA's estimate, the agency will save \$441 million in capital costs because it will not continue to procure modernized equipment for the flight service stations. Additionally, FAA expects to save \$1.2 billion in operating costs. However, the projected operating cost savings would not occur until fiscal year 2011 or later; only about \$241 million savings in operating costs would be realized through fiscal year 2010.³ For fiscal years 2005 through 2010, FAA also projects savings of \$212 million in operating costs from a variety of other actions, including improvements in procurement for office supplies, office equipment, mail, printing and information technology hardware and software; improving cell phone contracting; and cutting night shift operations at selected ATC towers.

These cost control efforts are not likely to close the projected gap. In total, the estimated operating cost savings that the agency could realize from current cost-reduction actions is \$454 million through fiscal year 2010—far short of the projected gap. However, additional options for cost savings exist. Some will require FAA to address organizational barriers and receive strong political support for implementation. Frequently cited cost control strategies are described below.

³FAA also saved \$494 million in operating costs through staff attrition that occurred in advance of contracting out. FAA did not fill these vacancies because it was planning to contract out the flight service stations.

- *Consolidate major air traffic control facilities.* A 1997 Coopers & Lybrand report concluded that the number of these centers could be reduced without a negative impact on air safety, but that such an initiative was considered unfeasible without strong political support for cost control.⁴ Some stakeholders told us that six or fewer facilities could be sufficient. FAA officials said they have no plans to consolidate centers because the concept would require strong political support that is not yet evident and they have no current financial estimate of potential savings. In addition, FAA's Management Advisory Council⁵ recently recommended that FAA develop a plan for reducing the number of terminal radar approach control facilities from their current level of 150 aging and inefficient facilities to around 50 to 60 newer, upgraded facilities using more capable and efficient automation.
- *Consolidate regional offices.* According to the Coopers & Lybrand and the National Civil Aviation Review Commission reports, FAA could achieve savings by consolidating its nine regional offices. Both reports said that FAA had studied the issue numerous times but had never acted on the results of its own studies. According to the commission's report, consolidating nine FAA regional offices into three could save \$400 million over a 5-year period. Several stakeholders told us this is an initiative that FAA should pursue.
- *Expand the Contract Tower Program.* Although FAA employees staff control towers at most of the nation's busiest airports, FAA contracts for outside staff to work at over 200 airports with lower traffic levels. Both the Coopers & Lybrand study and the commission report recommended expanding the contract tower program to achieve savings of \$20 million to \$30 million per year. More recently, the Department of Transportation's Office of the Inspector General reported that each contract tower costs FAA nearly \$900,000 less per year than comparable FAA towers, without compromising flight safety.

⁴Coopers & Lybrand, L.L.P., *Federal Aviation Administration Independent Financial Assessment* (Feb. 28, 1997).

⁵In 1996, Congress authorized the Administrator of the FAA to establish the Management Advisory Council. The council reviews, comments, and makes recommendations on FAA management, policy, spending, funding, and regulatory matters affecting the aviation industry. On May 12, 2005, the council issued a report that included suggestions for reducing FAA's costs.

- *Decommission infrastructure.* Aviation stakeholders noted that savings could be achieved by decommissioning ground-based navigational aids, but FAA has been slow to take action. As of May 2005, approximately 2,200 ground-based navigation aids were in operation. At the same time, FAA is fielding costly satellite navigation systems such as WAAS, but has made little progress in decommissioning the ground-based infrastructure. Its current plan calls for modest equipment retirements over the next 5 years and more substantial decommissioning over the next 10 to 15 years. According to one estimate, these actions could save \$150 million per year. FAA maintains that a long decommissioning process is required because general aviation users will continue to rely on some of these systems until their aircraft are upgraded to use satellite-based navigation. Several stakeholders commented that responding to the general aviation community on this issue has long been a roadblock to decommissioning obsolete equipment, and the ATO cannot afford to maintain these systems indefinitely.

**To Fund Major System
Acquisitions through
Fiscal Year 2009, FAA
Has Cut Funding for
Planned Investments in
Other Areas**

FAA plans to spend \$4.2 billion on 16 major system acquisitions in fiscal years 2005 through 2009. (See table 4.)

Table 4: FAA Capital Funding Plans for Major ATC Modernization Acquisitions

Dollars in millions

Major system	Funds planned for fiscal years 2005–2009
ERAM	\$1,531.8
STARS ^a	614.9
WAAS	570.8
FFP2	235.3
ASR-11	230.8
NEXCOM	212.8
ATOP	197.7
FTI	163.4
ASDE-X	107.9
NIMS-2	104.2
ITWS	77.7
ECG	74.3
ATCBI	73.7
OASIS	31.7
LAAS	9.9
CPDLC	2.9
Total	\$4,239.8

Source: GAO analysis of FAA data.

Note: Amounts shown in the table for NEXCOM, LAAS, and CPDLC reflect cuts previously described in this chapter.

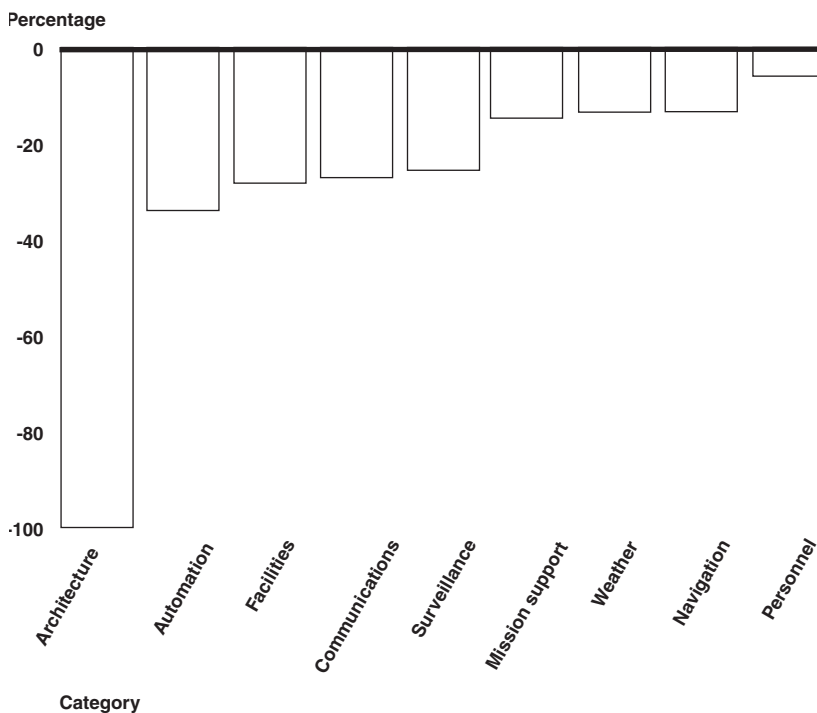
^aFunding includes the remaining STARS acquisitions for fiscal years 2006 and 2007 and \$256.5 million for the Terminal Automation Modernization Replacement (TAMR) program. In 2004, FAA decided to end the STARS acquisition in fiscal year 2007 and began TAMR. FAA plans to continue terminal modernization incrementally under TAMR, but has not formally approved its funding. For purposes of this table, we are treating STARS and TAMR as a single acquisition.

As table 4 shows, ERAM is a major component of FAA's system acquisitions. This system will replace the software and hardware in the current en route host computers at 20 of FAA's air route traffic control centers.⁶ This acquisition is still in its early stages, but will consume 35 percent of FAA's total estimated funding planned through 2009 for the 16 systems listed in table 4.

⁶ERAM will not be installed at the Anchorage, Alaska, air route traffic control center.

To provide the \$4.2 billion for its major system acquisitions in fiscal years 2005 through 2009 while remaining within its budget targets, FAA has reduced funding planned for new technology, facilities, and airport improvements, among other things. (See fig. 15.)

Figure 15: Percentage Reductions in Capital Investment Plans as of January 2005, Compared with January 2003



Source: GAO presentation of FAA data.

FAA Has Reduced Funding for New Technology That Could Produce Future Benefits

For fiscal years 2005 through 2009, FAA eliminated the \$1.4 billion that it had set aside for what it calls the “architecture segment.” These funds would have been used to perform about 2 years’ worth of early research on new programs that have not been officially approved as part of an acquisition decision by FAA management. According to FAA officials, these new programs will be postponed until they are affordable.

Architecture segment funds would have funded some technology developments intended to serve as cornerstones of FAA’s planned evolution

from a controller-based ATC system to one that relies more on collaboration between pilots and controllers and on better use of the technology on board an aircraft for safe navigation. For example, architecture segment funds would have been used to develop, among other things, the System Wide Information Management network (SWIM). SWIM would help transition the NAS to network-centric operations by providing the infrastructure and associated policies and standards to enable information sharing among all authorized NAS users, such as the airlines, other government agencies, and the military.

The architecture segment would also have funded the initial development of Automatic Dependent Surveillance-Broadcast (ADS-B), which FAA describes as another cornerstone of its long-term plans. ADS-B is a surveillance technology that transmits an aircraft's identity, position, velocity, and intent to other aircraft and to ATC systems on the ground, thereby enabling pilots and controllers to have a common picture of airspace and traffic. By providing pilots with a display that shows the location of nearby aircraft, the system enables pilots to collaborate in decision making with controllers, safely allowing reduced aircraft separation and thereby increasing NAS capacity.

Eliminating the architecture segment comes at an inopportune time, as the JPDO begins its congressionally mandated efforts to coordinate the research efforts of FAA and other federal agencies to create the Next Generation Air Transportation System that would provide capacity to meet the air transportation needs of 2025. The JPDO issued a report in 2004 outlining its plans to triple NAS capacity by 2025 and proclaimed that it can reach this goal only by completely transforming the way air traffic is managed. Network-centric operations and improved surveillance technology, such as SWIM and ADS-B might provide, are key elements of this transformation. A senior JPDO official told us that the JPDO's planning is still at an early stage, and therefore, the JPDO is not certain whether SWIM or ADS-B, as currently configured, would address NAS needs for 2025. However, he said that further development work is needed on these and other new technologies, and consequently, the JPDO hopes to see some funding for early technology development restored in FAA's capital investment plans as FAA's fiscal year 2007 budget request moves forward.

According to FAA, the program requirements for new technologies included in the JPDO's plans for the future were not mature enough, and business cases were not validated at that time, to justify inclusion within

FAA's constrained capital investment plan. FAA stated that it plans to work with the Department of Transportation, the Office of Management and Budget, and congressional appropriations committees to introduce new technologies associated with the JPDO's future plans. We believe that FAA needs to give continuing priority to developing business cases for new technologies such as ASD-B and SWIM. Such actions will help FAA and the JPDO transition the current NAS to the next generation air transportation system.

FAA Has Reduced Funding for Facilities

FAA cut nearly \$790 million from its planned investments for facilities—an action that could delay actions on facilities scheduled for repair or replacement. Much of FAA's infrastructure—the buildings and towers that house ATC employees and costly systems—is aging. (See table 5.) For example, the Casper, Wyoming, air traffic control tower was built in 1937; the tower in Binghamton, New York, was built in 1951; and FAA's newest air route traffic center was occupied in 1963. The average age of air traffic control towers at airports is 30 years. FAA's chief operating officer told us that the Houston traffic control center floods during heavy rains. Fire suppression systems are another concern, he said. While FAA has replaced more than 30 air traffic control towers and terminal radar approach control facilities in the last 5 years, the funding reduction could delay progress on ATC facilities that are scheduled for repair or replacement in the future.

Table 5: Age of NAS Facilities

Facility	Average age
Air route traffic control facilities (that house en route ATC operations)	43 years
Air traffic control towers (that house airport ATC operations)	29 years
Terminal radar control facilities (that house ATC approach and departure operations)	25 years

Source: FAA.

The capital spending reductions that FAA has planned for fiscal years 2005 through 2009 reflect the end result of difficult decisions about which programs to fund and which to cut in order to remain within budget targets. However, as we recently reported, FAA does not provide sufficient information to senior agency, department, Office of Management and

Budget, and congressional decision-makers of how it has arrived at its spending plans.⁷ Specifically, FAA does not identify the impact of these decisions on ATC and NAS modernization. Such information would make clear how constrained budgets will affect NAS modernization and how FAA is working to live within its means. Accordingly, we recommended that FAA begin providing such information with its budget submissions to Congress. FAA informed us that it intends to better inform Congress in the future by adding a section to its annual capital investment plan that will summarize major changes from the preceding year.

FAA Is Reviewing Potential Changes in Its Funding Mechanism

With the various taxes that accrue to the Trust Fund scheduled to expire in 2007, and FAA's reauthorization, also scheduled for 2007, many aviation experts, as well as top Department of Transportation and FAA officials, are revisiting the way FAA receives its funding and are repeating recommendations made in the past, such as those of the National Civil Aviation Review Commission in 1997. Aviation experts and stakeholders agree that the incomplete implementation of these recommendations and additional factors could limit FAA's ability to fully address long-standing NAS modernization problems.

The ATO, as Created, Implemented Only Part of the 1997 Commission's Recommendations

The 2000 executive order and related legislation that laid the foundation leading to FAA's creation of the ATO did not implement all of the recommendations of the National Civil Aviation Review Commission. The report stressed that the recommendations composed an integrated and comprehensive funding package and that the commissioners' agreement on the recommendations was contingent on their implementation as a total package. The report stated that implementing the recommendations in total could put FAA and aviation stakeholders in a position to take advantage of industry growth and technological change. The commission recommended the following:

- FAA's budget treatment must change. The commission recommended that FAA's funding and financing system receive a federal budget treatment ensuring that revenues from aviation users and spending on aviation services are directly linked and shielded from discretionary

⁷GAO-05-331.

budget caps. This linkage would ensure that FAA's expenditures are driven by aviation demand.

- FAA's management must become performance based. The commission recommended that services related to the air traffic system be placed in a performance-based organization, managed by a chief operating officer, and overseen by a board of public interest directors. In addition, FAA should institute a cost accounting system and be given authority to implement innovative programs involving leasing and borrowing authority. The commission further stated that the safety and security functions of FAA, which are separate from the performance-based organization, should also adopt a performance-based management philosophy so that the quality of these programs can be improved.
- FAA's revenue stream must become more cost based. The commission recommended that FAA adopt a cost-based revenue stream to support its air traffic system activities including capital investments. At the same time, funding for aviation security, safety, and government use of the air traffic system should be provided by the federal government's general fund.
- FAA must control its operating costs and increase capital investments. The commission reviewed FAA's forecasted budget needs and assumed the agency's budget projections to be reasonable in a status quo environment. However, the commission noted that FAA's operating costs could be better managed and controlled and that investments in ATC modernization should be increased.
- Airport capital needs must be met. The report noted that the federal requirements of airport capital development exceeded the amount of revenue that was available to finance these requirements through the Airport Improvement Program. The commissioners believed that the Airport Improvement Program is the linchpin of airport financial planning and stated that the program should be funded at a minimum of \$2 billion annually over the next 5 years.

While we do not necessarily agree with all of the commission's recommendations, we note that they were not implemented as a complete package, as the commission intended. Indeed, the ATO has been created as a legislatively mandated performance-based organization, headed by a chief operating officer, and focused on cost control, as the commission recommended. However, creating the ATO did not change its funding mechanism—a topic currently under discussion as the Trust Fund and FAA's reauthorizations are about to expire. Additionally, FAA's spending remained subject to congressional appropriations and the ATO was not given authority to implement innovative programs involving leasing and borrowing. Furthermore, the Trust Fund continues as a partial funding source for aviation security and safety.⁸

Aviation Experts and Stakeholders Repeated Several Past Recommendations

With the Trust Fund's scheduled 2007 expiration, and FAA's reauthorization drawing near, stakeholders, aviation experts, and Department of Transportation officials are discussing whether or how the Trust Fund should be changed to better meet FAA's needs. Potential changes echo those made by the commission in 1997. For example, FAA's 2004 performance report notes that the FAA's funding mechanism does not link revenues with FAA's cost of providing ATC services.⁹ The report states that Trust Fund revenues are affected primarily by the number of passengers in the NAS, while FAA's workload and costs are based on the number of aircraft operating in the NAS, regardless of the number of passengers on each aircraft. Given the same number of passengers, the Trust Fund's revenues would remain constant, even though the passengers may be traveling on more, smaller aircraft. Under this scenario, FAA's workload and costs would increase but FAA's income would remain the same. The FAA Administrator noted that a tax on airline fares paid by passengers, which is the Trust Fund's primary source of revenue, is not related to FAA's actual cost of providing ATC services, and is not responsive to changes in the aviation industry. According to the Administrator, the United States is in a select minority of countries—all of them small, third world nations—that do not charge for the actual cost of air traffic control. She added that the current structure provides little incentive for FAA's customers to look at

⁸Security fees, collected as a fee imposed on airline passengers, also help pay for aviation security.

⁹FAA is funded through the Trust Fund and the General Fund. In fiscal year 2004, the General Fund provided 22 percent of FAA's total budget.

what things cost and help FAA to focus its resources where they matter the most. Under this system, she observed, “everyone wants everything and in a political environment, it becomes difficult ... often impossible ... to do things differently and undertake real reform.”

Some aviation experts also noted that FAA’s funding stream needs to be linked to the cost of its services and FAA needs multiyear funding, financed by debt if necessary, to effectively manage its acquisitions, as the commission recommended.¹⁰ FAA’s chief operating officer said that multiyear funding would provide needed stability, and a senior Department of Transportation official stated that 50 percent of acquisition cost overruns resulted from an unstable funding stream. One stakeholder concluded that, at the present time, a window of opportunity may exist to seriously reexamine past recommendations that have been repeated over time, such as those of the commission. However, not all stakeholders agree that significant changes are needed. The National Air Traffic Controllers’ Association, the labor union representing air traffic controllers, testified that the Trust Fund is a stable and strong source of revenue and structural changes should not be taken lightly.

Some aviation experts and our work suggests steps that FAA could take in the short term to improve its performance-based characteristics within the existing structure of congressional oversight and financial control. For example, one expert suggested that FAA has room for improvement in prioritizing how it commits to programs that require future investments, keeping in mind realistic funding assumptions. Another noted that FAA’s anticipated high retirement rate over the next few years provides an opportunity to cut costs by redistributing and trimming the workforce. Finally, some experts suggested that if contracting for flight service stations proved to be effective, FAA could consider contracting for other functions, such as oceanic or en route ATC, or nighttime operations. Under this option, experts noted that ongoing government oversight could ensure the safety of contracted operations, and a “staged outsourcing” of the NAS’s functions might build confidence in the private sector’s ability to provide air traffic services safely and efficiently. As previously discussed,

¹⁰As part of our research, we sought the perspective of an international group of experts. We asked these experts to address, among other things, short-term steps that the ATO could take to address funding constraints and longer term steps that FAA could take to help the ATO achieve its mission. The options presented were identified by one or more members of our expert panel or others that we interviewed and do not necessarily reflect the views of GAO or of all aviation experts.

our work has also pointed out cost-saving options that FAA could pursue, such as consolidating ATC facilities and regional offices, decommissioning ground-based navigational aids, and expanding the contract tower program.

Other experts went so far as to state that FAA, through the ATO, cannot fully address legacy modernization problems unless the ATO receives managerial and budgetary independence. To this end, some stated that the ATO's basic relationship with Congress must be changed so that ATO has the authority to manage its own finances, as the private sector does. Experts noted that, in contrast to the independence, flexibility, and tools available to private business executives, the business decisions made by the ATO's executives are subject to review by the FAA Administrator, the Secretary of Transportation, the Office of Management and Budget, and Congress. Increasing the ATO's autonomy would entail fundamental structural changes to the how the ATO receives and spends funding.

Considering such fundamental changes is consistent with our work on the challenges facing this nation in the 21st Century. Addressing these challenges requires a fundamental reexamination of government policies, programs, and functions to determine what the federal government should do and how it should be financed in the future. Concerning transportation, federal decision makers need to ask whether existing program constructs and financing mechanisms are relevant to the challenges of the 21st Century.

Conclusions

The current tight budget environment has forced FAA to make some tough decisions, the implications of which may not be apparent to executive branch and congressional decision makers. Including information in its budget submissions on the impact of these decisions, as we previously recommended, will enable FAA to provide decision makers with a better understanding of the funding trade-offs it is proposing. FAA's current capital investment plan sacrifices funding for the early development of new technologies—included in the JPDO's plans for the NAS of the future—to make funding available for ongoing modernization projects. Although many of these ongoing projects are supportive of the JPDO's vision, eliminating the funding for research and development for new technologies runs counter to the JPDO's objectives. Balancing the needs of ongoing and future projects is essential to provide for transforming the NAS, both in the near term and by 2025.

The costs of hiring and training thousands of controllers annually for the next decade, as discussed in chapter 3, add to FAA's financial challenges. It is important that FAA estimate these costs now, so that it can incorporate them in future budget requests. These cost estimates will affect the amounts of funding FAA will have available for modernization as well as operations.

The observations of aviation experts and stakeholders, as well as our work on the nation's 21st Century challenges, suggest a two-staged approach to addressing FAA's financial management challenges. First, FAA needs to pursue those options available under the existing federal oversight and appropriations process, such as exploring opportunities for contracting out more of its services, and consolidating facilities. Once FAA has fully exploited those options, and has established a record of improved financial management, it could consider developing a business case to reexamine fundamental issues such as the appropriate government role in aviation and the funding mechanism that support the ATC system. Ultimately, Congress and the President decide these issues.

Recommendations for Executive Action

To position FAA to best meet NAS needs in both the near term, and the longer term, we are making the following two recommendations to the Secretary of Transportation. The Secretary should direct the FAA Administrator to (1) balance current and long-term investment priorities; and (2) use all available management tools and, after establishing a record of improved financial management, explore more fundamental changes that could provide greater financial management flexibility.

Agency Comments and Our Evaluation

FAA commented that its fiscal year 2007 budget request will reflect its balancing of current and future funding priorities, and, therefore, our recommendation to this effect may be unnecessary. We are retaining this recommendation because it pertains not only to fiscal year 2007, but to future years as well. Likewise, FAA commented that it is already utilizing all available financial management tools, including looking at alternative financing mechanisms. We continue to believe that FAA should explore further uses of available management tools such as opportunities to contract out its services; consolidate major facilities; and accelerate decommissioning of ground-based navigation aids, as we have noted in this report. Therefore, we are also retaining this recommendation. FAA also provided technical comments, which we included as appropriate.

Methodology for Workforce Culture Assessment

Because we identified the acquisition workforce culture as an underlying cause of air traffic control (ATC) modernization problems in 1996 and had not revisited this area since the Federal Aviation Administration (FAA) published its strategy for cultural change in 1997, we reassessed the status of FAA's efforts in this area. We obtained documents that showed evidence of the steps that FAA took to improve the acquisition workforce culture between 1997 and 2005. To benchmark the acquisition workforce against organizations with constructive cultures, we employed the services of a consultant with extensive experience in analyzing organizational culture and used a research database of responses to the Organizational Culture Inventory® and Organizational Effectiveness Inventory™. These instruments have been administered over a period of 20 years to nearly 1,000 organizations selected to maximize the number and diversity of the organizations represented in the database.

The research database does not contain client data—that is, data obtained from organizations that contracted for an organizational assessment. Such data would be subject to self-selection biases because the factors prompting the use of culture and climate surveys by such organizations almost ensure that the results will be skewed and somewhat negative. Additionally, the types of organizations (typically large, for-profit corporations) that undertake, and can afford, such surveys are not necessarily representative of the larger population of organizations. Instead, the organizations, whose responses are in the research database, were strategically selected and invited to use the surveys on a research basis.¹ Additionally, priority was placed on gaining entrée into a number of highly effective organizations, including some that initially turned down the invitation on the grounds that their cultures represented a competitive advantage and were proprietary. Thus, though not collected from a random sample of organizations, the research data are less subject to systematic biases than are client-based data.

The research database provides both “historical averages” and “constructive benchmarks” against which organizations can compare their results. The historical averages, for the purposes of this study, are the mean scores for all respondents across the organizational units surveyed. The

¹The research database includes responses from government agencies, not-for-profit organizations, public and private schools, libraries and museums, sports teams and athletic organizations, professional groups, and small businesses. Approximately 10 percent of the respondents in the research database are from public agencies, a rate that is significantly higher than would be the case for a client database.

constructive benchmark scores are the averages for up to 172 highly effective units—defined as those with predominately positive and adaptive cultures. These scores provide a target toward which organizations can work to redirect their cultures and enhance their performance.

We compared the results in the research database with those that FAA obtained through its periodic employee attitude survey. Specifically, we used 1997, 2000, and 2003 survey results for the acquisition workforce, the same segment of the organization that we focused on in 1996. In each of these years, FAA mailed surveys to the entire acquisition workforce and received completed surveys from approximately half of the workforce, as summarized in table 6.

Table 6: Number of Surveys That FAA Mailed to the Acquisition Workforce and Completed Surveys Received in 1997, 2000, and 2003

Year	Surveys mailed	Completed surveys returned
1997	2,051	1,004
2000	1,983	1,057
2003	1,825	928

Source: GAO representation of FAA data.

The results derived from these completed surveys could differ if a different subset of the workforce responded. Consequently, we treat the completed surveys as a random sample of the workforce to acknowledge the sampling error that would be expected for a probability sample of this size. This treatment assumes that response is random and that the completed surveys constitute a simple random sample of the acquisition workforce. If this assumption is not correct, for example, if employees with positive attitudes were more (or less) likely to respond than employees with negative attitudes, then the scores developed from the survey results could overstate (or understate) the scores for the workforce overall.

Mean scores were developed from the survey data by assigning values of 1 through 5 to the five-point extent scales for each question, and then using these score values to estimate an average score based on all responses for that question.² We express our confidence in the precision of these score estimates at 95 percent confidence intervals. This is the interval that would contain the actual population value for 95 percent of the samples we could have drawn. As a result, we are 95 percent confident that each of the confidence intervals in this report will include the true values in the study population. For the estimated acquisition workforce scores in this report, the 95 percent confidence intervals are within plus or minus .06 points of the score estimate. For example, if the estimated score is 3.21, then the 95 percent confidence interval would run from 3.15 to 3.27.

With our expert's assistance, we selected items from FAA's employee attitude survey that addressed cultural issues and matched them with similar survey items used to assemble the research database. Each of our comparisons addressed a common aspect of organizational culture or climate. For example, FAA's survey asks for agreement or disagreement with the following statement: "In my organization, there are service goals aimed at meeting customer expectations." We compared FAA's responses to the following item used in the comparison group survey: "Are you encouraged to emphasize the perspective and needs of customers when making decisions?" Appendix III shows a complete list of FAA survey items and comparison group survey items that we used for comparison, and the respective scores.

It is important to note that comparisons of the responses to questions whose wording is similar, but not identical, are difficult because even subtle changes in a question's wording can result in different outcomes. We present the two sets of survey results here because they are measuring similar enough concepts that we think a general comparison is warranted. Additionally, we used the results of our comparisons as part of a body of evidence that also includes our past work on FAA's culture, and FAA's more recent recognition of the importance of a results-oriented culture.

²Responses to questions range over a five-point scale. For example, the possible responses might be: strongly disagree, disagree, neither agree nor disagree, agree, strongly agree. In this case, if "strongly agree" were the most positive response for the question, it would be scored a "5," "neither agree nor disagree" would score a "3," and "strongly disagree" would score a "1."

We believe that the research database is sufficiently authoritative, appropriate, and reliable for us to use it as a basis for comparing FAA's workforce culture with other organizations' cultures. The survey that was used to create the database has been completed by over 2,500,000 respondents since its publication in prototype form in 1983. It has been administered in thousands of organizations throughout the world, including the Department of the Navy, the Coast Guard, the Defense Logistics Agency, major retailing organizations, international pharmaceutical companies, financial services corporations, newspapers, high tech firms, universities and hospitals, not-for-profit organizations, and numerous manufacturing firms. These organizations have variously used the results to diagnose their cultures and initiate change programs, to identify the "ideal" culture for maximizing their effectiveness, and to monitor the impact of organizational development efforts. More specialized applications have included programs focusing on diversity within organizations, mergers and acquisitions, and union-management relations.

Additionally, the survey is referenced in various textbooks and has been adopted for instructional purposes by leading universities. It has been used in research projects on topics ranging from organizational reliability and effectiveness to member socialization and citizenship behavior. These projects include a Department of Defense study of the culture of highly effective units during the Desert Shield buildup; a comparative study of 150 supermarkets sponsored by the Coca-Cola Retailers' Research Council; the Readership Institute's (Northwestern University) national survey of 100 newspapers; and various projects focusing on organizations carrying out critical activities (e.g., nuclear power plants, nuclear aircraft carriers, critical care units). The survey has also been used in international cross-cultural projects, including one by the International Association of Economic and Management Students focusing on management cultures in over 40 different countries. The survey has been published in Bulgarian, Chinese (traditional and simplified), Dutch, Finnish, French (European and Canadian), German, Icelandic, Japanese, Korean, Portuguese, Romanian, Russian, Spanish (Castilian and Latin American), and Swedish, and preliminary translation keys have been developed in Afrikaans, Hindi, Polish and other languages. Results of research supporting the scientific reliability and validity of the survey have been published in *Psychological Reports*, *Group and Organization Studies*, *Human Relations*, and the *Handbook of Organizational Climate and Culture*.

Similarly, we believe FAA's employee attitude survey is sufficiently authoritative, appropriate, and reliable for us to use it as a basis for

**Appendix I
Methodology for Workforce Culture
Assessment**

comparing FAA's workforce culture over time. FAA has administered the employee attitude survey to its employees nine times since 1984. The survey was designed to gather information on employees' attitudes, perceptions, and opinions about a broad variety of organizational issues. Although elements of the survey have changed over time, items thought to represent core areas of interest have remained relatively unchanged. For our analysis, we used FAA's data showing the acquisition workforce's responses for surveys conducted in 1997, 2000, and 2003. The acquisition workforce's response rate for these years was, respectively, 49 percent, 53 percent, and 51 percent.

Major ATC System Acquisitions

Air Traffic Control Radar Beacon Interrogator— Replacement (ATCBI-6)

ATCBI-6 is a replacement radar capable of determining both range and direction to and from the aircraft. It can also forward this information to the appropriate air route traffic control centers. It will replace radars that have exceeded their life expectancy and have proved extremely vulnerable to outages and critical-parts shortages.

Advanced Technologies and Oceanic Procedures (ATOP)

ATOP is an integrated system of new controller workstations, data-processing equipment, and software that will enhance the control and flow of oceanic air traffic to and from the United States. ATOP is planned for the three sites that control oceanic air traffic: Anchorage, Alaska; New York, New York; and Oakland, California.

Airport Surface Detection System- Model X (ASDE-X)

ASDE-X is an airport surveillance system that enables air traffic controllers to track the surface movement of aircraft and vehicles. The detection system automatically predicts potential conflicts and seamlessly covers airport runways, taxiways, and other areas.

Airport Surveillance Radar Model-11 (ASR-11)

ASR-11 is a digital radar that replaces aging analog radars, such as ASR-7 and ASR-8, as well as collocated ATCBI-4 and ATCBI-5 secondary radars, with a single, integrated digital radar system. ASR-11 reduces operational costs, improves safety, and can accommodate future capacity increases.

Controller-Pilot Data Link Communications (CPDLC)

CPDLC is a communication system that will allow pilots and controllers to transmit data messages directly between FAA automated ground computers and aircraft.

En Route Automation Modernization (ERAM)

ERAM will replace software and hardware in the host computers at FAA's 20 en route air traffic control centers, which provide separation, routing, and advisory information. It provides a flexible and expandable base to facilitate further National Airspace System (NAS) modernization initiatives.

En Route Communications Gateway (ECG)

A precursor to ERAM, ECG provides a communications interface between radar sites and en route centers. The system has an open and expandable platform that allows for new connectivity and functionality as the NAS evolves. It replaces the interim Peripheral Adapter Module Replacement Item that has been operating for 10 years and has exceeded its life expectancy.

FAA Telecommunications Infrastructure (FTI)

FTI is FAA's new telecommunications system. It will replace costly networks of separately managed systems and services—both leased and owned—by integrating advanced telecommunications services within FAA's NAS and non-NAS infrastructures.

Free Flight Phase 2 (FFP2)

FFP2 is a suite of air traffic control tools and subsystems that allows air traffic controllers to move gradually from a highly structured system, based on elaborate rules and procedures, to a more flexible system wherein pilots, within limits, can change their route, speed, and altitude while keeping air traffic controllers informed of such changes. It includes the Traffic Management Advisor, Collaborative Decision Making, and the User Request Evaluation Tool.

Integrated Terminal Weather System (ITWS)

ITWS is a weather information system that furnishes air traffic controllers and supervisors with full-color graphic displays of weather conditions that need no meteorological interpretation. It provides a comprehensive representation of the current weather situation and precise forecasts of weather conditions for the next 20 minutes (to be increased to 60 minutes in 2006) of convective weather conditions.

Local Area Augmentation System (LAAS)

LAAS is a landing guidance system that would use global positioning satellites and would be installed at airports to allow aircraft to execute precision instrument approaches and landings in all weather conditions. LAAS would eliminate the need for multiple instrument landing systems at airports where it is installed.

NAS Infrastructure
Management System—
Phase 2 (NIMS-2)

NIMS is a centralized system to help manage and schedule maintenance on the NAS infrastructure, including its facilities, systems, and equipment. NIMS will decrease the number of en route delays by reducing the time required to restore systems to full operation following maintenance. NIMS Phase 1, already complete, provides initial Operational Control Center capability, along with remote monitoring and control functionality, to 3,700 NAS facilities and 5,800 deployed maintenance data terminals.¹ Phase 2 will fully implement resource management and enterprise management software and focus on increasing workers' productivity in receiving orders and managing resources.

Next Generation Air/Ground
Communications
(NEXCOM)

NEXCOM is a digital communications system, consisting of multimodal digital radios, avionics, and ground stations, that will improve ATC communications by replacing old analog communication systems. Segment 1A will replace 30- to 40-year-old radios, deploying 6,000 new radio sets that use both analog and digital communications with aircraft. Segment 1B will create ground stations to communicate with aircraft equipped with digital capability.

Operational and
Supportability
Implementation System
(OASIS)

OASIS is a system used at flight service stations to assist general aviation pilots with flight planning. The system provides up-to-the-minute weather graphics by integrating real-time weather and flight planning data with overlays of flight routes. It replaces the Flight Services Automation system for which FAA has had difficulty obtaining spare parts and hardware support.

Standard Terminal
Automation Replacement
System (STARS)

STARS is a workstation to allow civilian and military air traffic controllers to direct aircraft near major U.S. airports and will replace aging workstations at certain facilities. It has an open and expandable terminal automation platform that can accommodate air traffic growth, as well as new hardware and software that is designed to promote safety, maximize operational efficiency, and improve controllers' productivity. FAA will

¹Operational Control Center capability, established in 2001, was a standard set of tools and procedures needed to open the control centers. The tools provide the initial enterprise management and resource management technical capabilities needed at Operational Control Centers.

terminate STARS after replacing 47 older systems by the end of fiscal year 2007.

**Terminal Automation
Replacement (TAMR)**

TAMR is a modernization program to resolve existing safety, capacity, and obsolescence concerns in terminal automation systems at approximately 115 terminal radar approach control facilities and their associated towers. FAA initiated TAMR in 2004, concurrent with its decision to end STARS acquisitions by the end of fiscal year 2007. According to FAA, TAMR will incrementally continue the modernization and replacement actions.

**Wide Area Augmentation
System (WAAS)**

WAAS is a navigation and landing guidance system that uses global positioning satellites to provide precise navigation and landing guidance at all U.S. airports, including thousands that have no ground-based instrument landing capability.

Perceptions of Organizational Culture in FAA's Acquisition Workforce and in Other Organizations

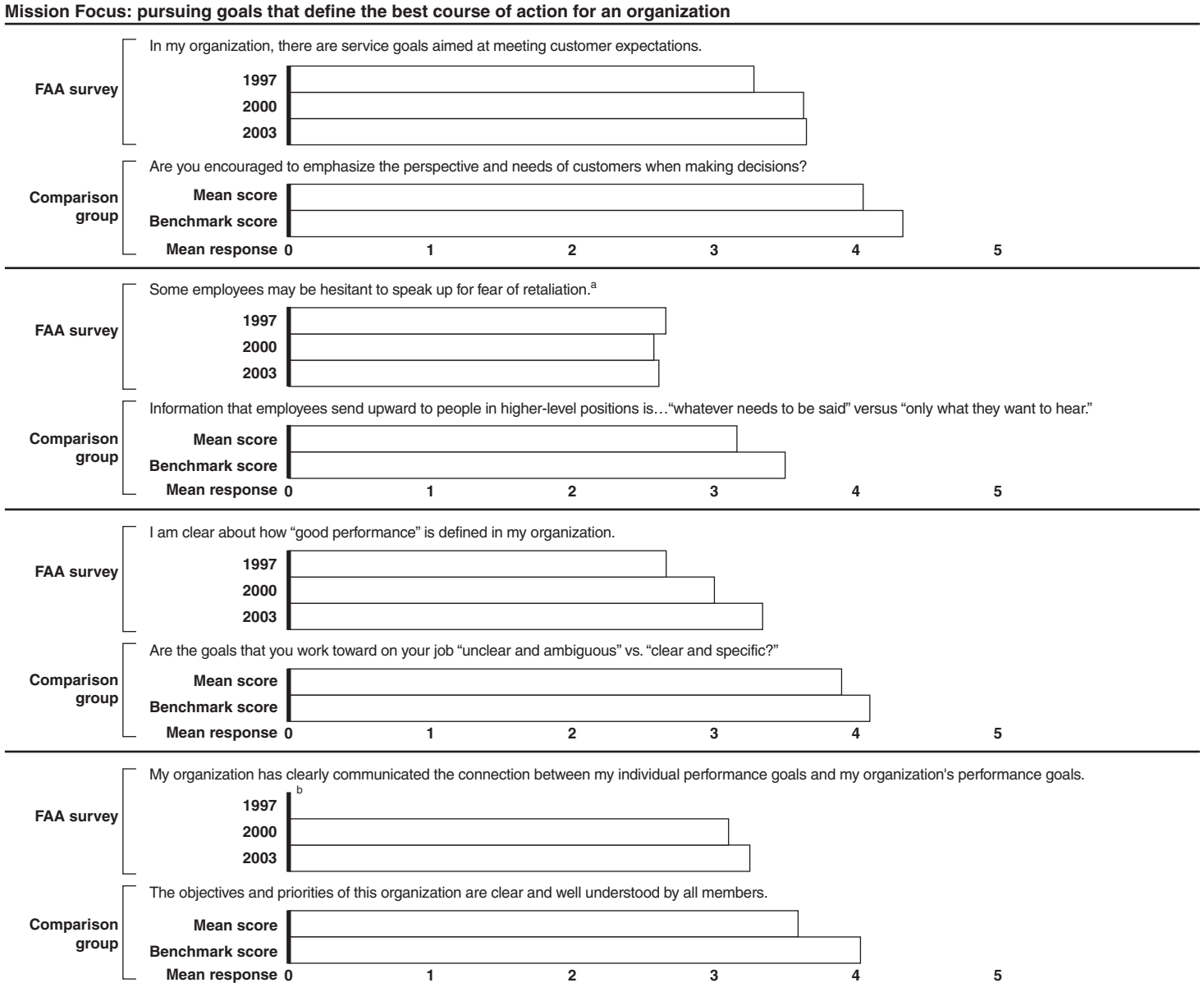
This appendix provides the results of surveys conducted at FAA and at a variety of other organizations (comparison group). FAA has conducted employee attitude surveys periodically since 1984, and most recently in 1997, 2000, and 2003. At the other organizations, Human Synergistics, International, has surveyed employees over a 20-year period to develop a database for research on organizational culture and climate, as discussed in appendix II, using its Organizational Culture Inventory® and its Organizational Effectiveness Inventory™ (see app. II for more detail about these inventories). Human Synergistics also identified a subset of these organizations as highly effective organizations with constructive cultures.

To compare the perceptions of FAA's acquisition workforce with the perceptions of employees at other organizations, including those organizations with constructive cultures, we compared the mean responses of FAA and other employees to similar items in their respective surveys. We selected four survey items to compare for each of four key factors associated with a constructive organizational culture—mission focus, accountability, adaptability, and coordination. In this appendix, we refer to the mean responses of the FAA and other employees as the mean scores for the survey items. Additionally, we refer to the mean responses of the constructive organizations' employees as the benchmark scores for the items.

Figure 16 presents the mean and benchmark scores for the four survey items associated with each of the four factors we considered. For FAA's acquisition workforce, we provide the mean scores, as calculated by FAA, for each item from the agency's 1997, 2000, and 2003 surveys. For the employees of the other and the highly effective organizations, we provide the mean and the benchmark score for each item that we obtained from the research database. We display these scores in consecutive charts whose juxtaposition shows how the perceptions of FAA acquisition employees compare at three points in time with the perceptions of employees at other organizations generally and at organizations with constructive cultures.

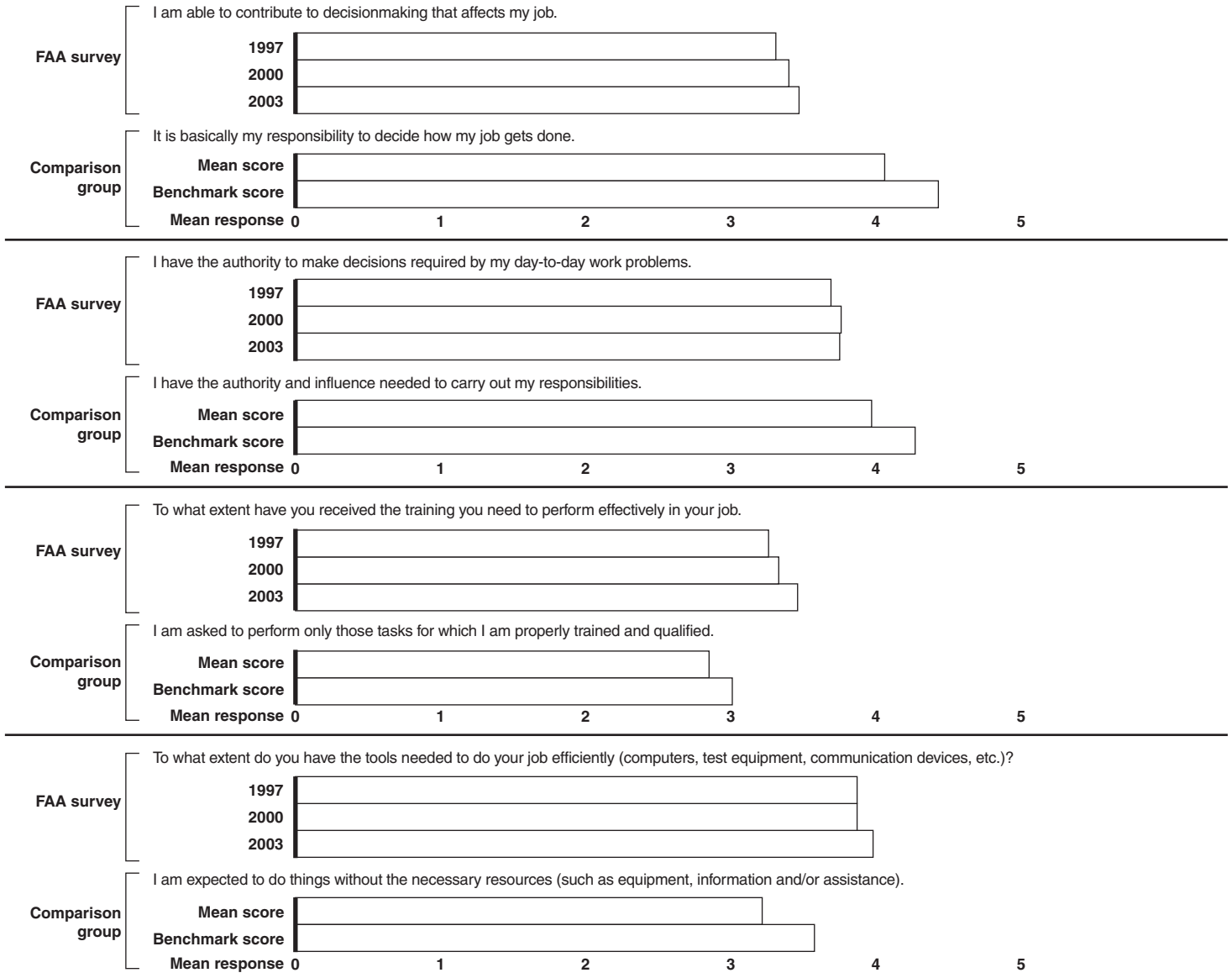
**Appendix III
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Figure 16: Acquisition Workforce's Mean Responses to Selected Items from FAA's 1997, 2000, and 2003 Employee Attitude Surveys and Comparison Group's Mean and Benchmark Scores for Similar Items



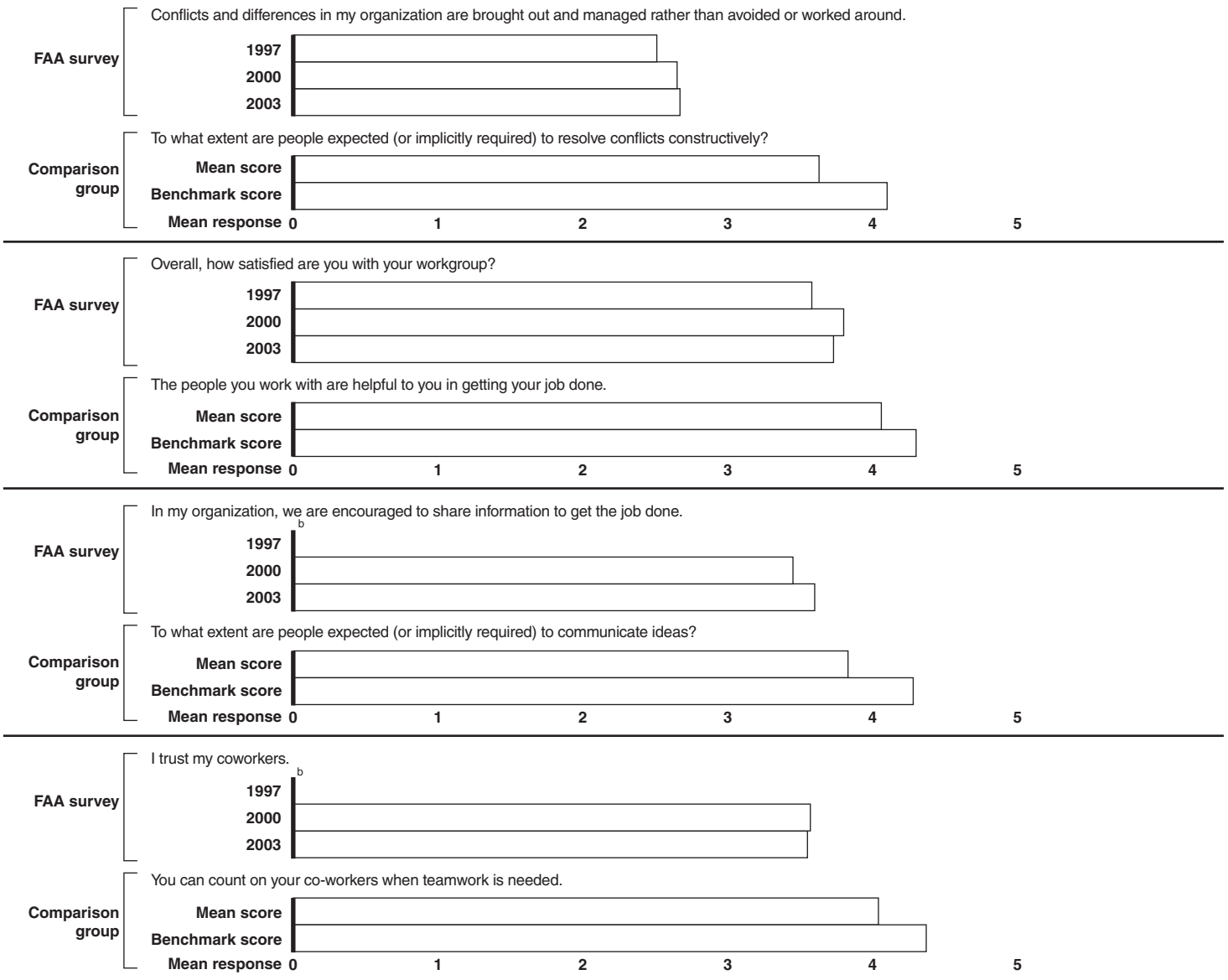
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Accountability: empowering employees and holding them responsible for their decisions and actions



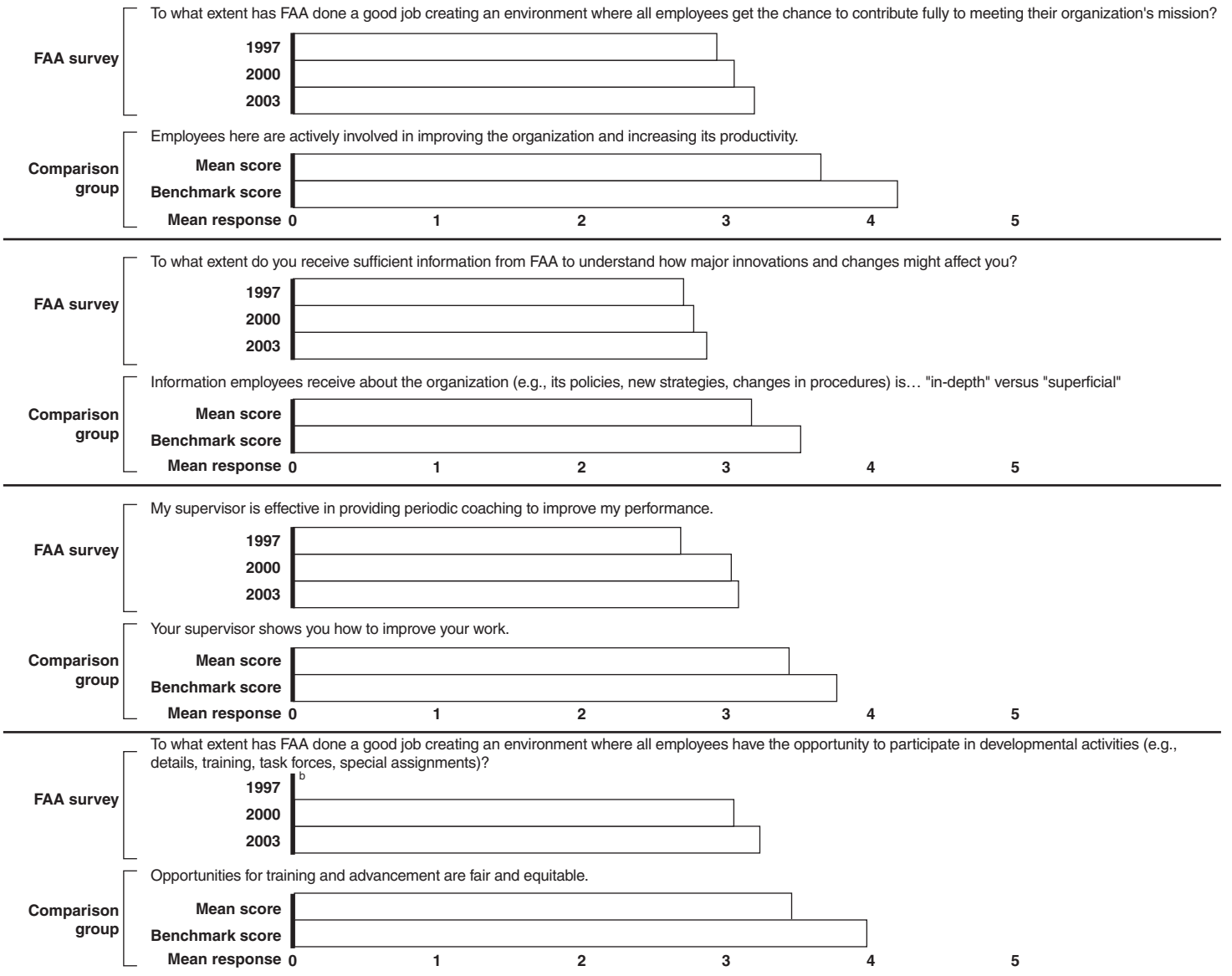
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Coordination: involving other employees in decisions affecting them, resolving differences collaboratively, and cooperating across organizational lines



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Adaptability: accepting new approaches and responding positively to demands and opportunities posed from within and outside of the organization



Source: GAO analysis of FAA data and research database compiled and used with permission of Human Synergistics, International.

Note: FAA score estimates have 95 percent confidence intervals of plus or minus 0.06 or less. Differences in scores of 0.08 or more are significant at the 95 percent confidence level.

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^aThis question is negatively worded, such that "strongly agree," would be a negative response. For consistency, we reversed the scoring for this question, so that a "strongly agree" response would be scored 1, and a "strongly disagree" response would be scored 5. The practice of reverse scoring negatively worded items is a commonly accepted professional practice in survey research methodology.

^bNot asked on the 1997 survey.

Key Practices and Implementation Steps for Mergers and Organizational Transformations

Practice	Implementation steps
Ensure top leadership drives the transformation.	<ul style="list-style-type: none"> • Define and articulate a succinct and compelling reason for change. • Balance continued delivery of services with merger and transformation activities.
Establish a coherent mission and integrated strategic goals to guide the transformation.	<ul style="list-style-type: none"> • Adopt leading practices for results-oriented strategic planning and reporting.
Focus on a key set of principles and priorities at the outset of the transformation.	<ul style="list-style-type: none"> • Embed core values in every aspect of the organization to reinforce the new culture.
Set implementation goals and a time line to build momentum and show progress from day one.	<ul style="list-style-type: none"> • Make public implementation goals and time line. • Seek and monitor employee attitudes and take appropriate follow-up actions. • Identify cultural features of merging organizations to increase understanding of former work environments. • Attract and retain key talent. • Establish an organizationwide knowledge and skills inventory to allow knowledge exchange among merging organizations.
Dedicate an implementation team to manage the transformation process.	<ul style="list-style-type: none"> • Establish networks to support the implementation team. • Select high-performing team members.
Use the performance management system to define responsibility and ensure accountability for change.	<ul style="list-style-type: none"> • Adopt leading practices to implement effective performance management systems with adequate safeguards.
Establish a communication strategy to create shared expectations and report related progress.	<ul style="list-style-type: none"> • Communicate early and often to build trust. • Ensure consistency of message. • Encourage two-way communication. • Provide information to meet specific needs of employees.
Involve employees to obtain their ideas and gain ownership for the transformation.	<ul style="list-style-type: none"> • Use employee teams. • Involve employees in planning and sharing performance information. • Incorporate employee feedback into new policies and procedures. • Delegate authority to appropriate organizational levels.
Build a world-class organization.	<ul style="list-style-type: none"> • Adopt leading practices to build a world-class organization.

Source: GAO, *Results-Oriented Cultures: Implementation Steps to Assist Mergers and Organizational Transformations*, GAO-03-669 (Washington, D.C.: July 2, 2003).

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