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Testimony

Before the Subcommittee on AirLand,
Committee on Armed Services,
U.S. Senate

For Release on Delivery
Expected at 2:30 p.m. EDT
Wednesday, April 6, 2005

TACTICAL AIRCRAFT

F/A-22 and JSF Acquisition Plans and Implications for Tactical Aircraft Modernization

Statement of Michael Sullivan, Director
Acquisition and Sourcing Management Issues





Highlights of GAO-05-519T, a testimony before the Subcommittee on AirLand, Committee on Armed Services, U.S. Senate

TACTICAL AIRCRAFT

F/A-22 and JSF Acquisition Plans and Implications for Tactical Aircraft Modernization

Why GAO Did This Study

The F/A-22 Raptor and Joint Strike Fighter (JSF)—two of the Department of Defense’s (DOD) major tactical aircraft fighter programs—are intended to replace aging tactical fighter aircraft with highly advanced, stealthy aircraft. The two programs combined have a potential future investment of more than \$240 billion.

This testimony highlights key concerns in the F/A-22 and JSF programs and discusses the implications on DOD’s overall investment strategy for modernizing its tactical fixed-wing aircraft. Last month, GAO issued comprehensive reports on the numerous setbacks these programs have experienced since they were initiated and their effect on the F/A-22 and JSF business cases.

What GAO Recommends

GAO made recommendations in two reports issued in March 2005. For the F/A-22 program, GAO reiterated and expanded upon its 2004 recommendation for DOD to establish a new business case—one that justifies the continued expenditure of funds on the F/A-22. For the JSF program, GAO recommended that—before the program moves forward—DOD establish an executable business case that is consistent with best practices and DOD policy regarding knowledge-based, evolutionary acquisitions.

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To view the full product, including the scope and methodology, click on the link above. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

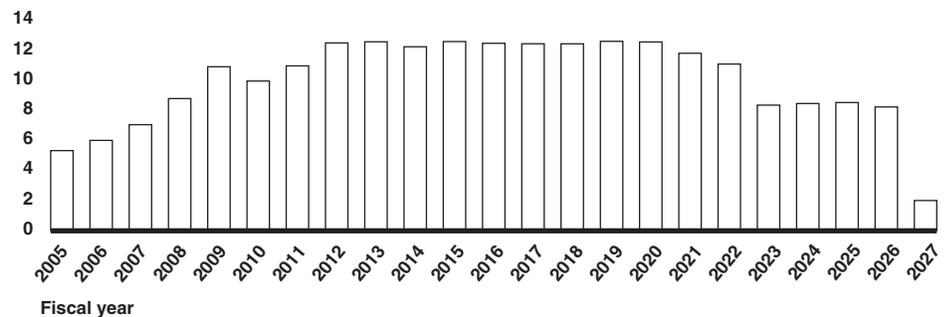
What GAO Found

Significant changes in the F/A-22 program have severely weakened its original business case. Since the F/A-22 program began in 1986, new threats emerged and mission requirements changed; to keep the F/A-22 viable, the Air Force has planned for large investments in new capabilities. Significant delays and cost increases have affected affordability, reducing planned deliveries from 750 F/A-22 aircraft to fewer than 180. The recent budget decision to terminate procurement of the F/A-22 after fiscal year 2008 and the prospect of additional funding cuts also have significant implications for the program’s viability and modernization efforts.

JSF’s original business case, established when the program began in 1996, is unexecutable. The cost estimate to develop the aircraft has increased 80 percent, operational capability has been pushed out 2 years, and expected acquisition quantities have been cut by 535 aircraft. The JSF program is approaching key investment decisions that will greatly influence the efficiency of the remaining funding—more than 90 percent of the \$245 billion estimated total program costs. This sizable investment greatly raises the stakes to meet future promises. While DOD has been working to resolve early design and performance problems, continuing program uncertainties suggest DOD could use more time to gain knowledge before it commits to a new business case and moves forward. To reduce the risk of further cost and schedule growth, any new business case must include an acquisition strategy that adopts an evolutionary, knowledge-based approach to product development. Currently, the JSF program plans to make key production decisions before critical knowledge is captured.

JSF Program’s Annual Funding Requirements from 2005 to 2027

Dollars in billions



Source: GAO analysis of DOD data.

Taken together, these issues have broader implications for the DOD tactical fixed-wing aircraft modernization program, raising questions as to whether overarching goals to reduce average aircraft age and ownership costs while maintaining the force structure are now achievable. The 2005 Quadrennial Defense Review provides an opportunity for DOD to assess needs and plans and to weigh options for accomplishing its tactical aircraft goals.

Mr. Chairman and members of the subcommittee:

I am pleased to be here today to participate in the Subcommittee's hearing on the status of two of the Department of Defense's (DOD) major tactical aircraft fighter programs, the F/A-22 Raptor and the F-35, also known as the Joint Strike Fighter (JSF).¹ Both programs are intended to replace aging tactical fighter aircraft with highly advanced, stealthy aircraft. These two programs represent a potential future investment for DOD of about \$240 billion to modernize tactical fixed-wing aircraft.

My statement today will highlight key concerns in the F/A-22 and JSF programs. Our work has shown that because of the significant changes in the F/A-22 development and procurement programs and the key investment decisions remaining, a new business case is needed to justify aircraft quantities and investments in new capabilities. Changes in the JSF program and DOD's intent to begin producing aircraft with at least 6 years of development remaining suggest that the JSF does not yet have the knowledge to justify future investments. In addition to highlighting specific F/A-22 and JSF program issues, I will discuss the implications these development programs have on DOD's overall investment strategy for modernizing the tactical fixed-wing aircraft.

My statement is primarily based on our recent reports on the F/A-22 and JSF programs.² We performed the work associated with this statement in accordance with generally accepted government auditing standards.

Summary

The F/A-22 has been in development for 19 years, and cost increases and delays have created affordability concerns that reduced the number of aircraft planned for acquisition. A changing world environment and threats over this time frame have compelled the Air Force to plan for large investments in new capabilities to keep the F/A-22 viable. Termination of F/A-22 procurement after fiscal year 2008 has also placed modernization

¹The third major program, the FA-18EF, currently in production, is not a subject of this testimony.

²GAO, *Tactical Aircraft: Status of the F/A-22 and JSF Acquisition Programs and Implications for Tactical Aircraft Modernization*, [GAO-05-390T](#) (Washington, D.C.: Mar. 3, 2005); GAO, *Tactical Airlift: Air Force Still Needs Business Case to Support F/A-22 Quantities and Increased Capabilities*, [GAO-05-304](#) (Washington, D.C.: Mar. 15, 2005); and GAO *Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy*, [GAO-05-271](#) (Washington, D.C.: Mar. 15, 2005).

plans in doubt. The original business case elements—needs and resources—set at the outset of the program are no longer valid, and a new business case is needed to justify future investments for aircraft quantities and modernization efforts. The F/A-22's acquisition approach was not knowledge-based or evolutionary. It attempted to develop revolutionary capability in a single step, causing significant technology and design uncertainties and, eventually, significant cost overruns and schedule delays. Lessons from the F/A-22 program can be applied to the JSF program to improve on its outcomes.

While relatively early in its acquisition program, the JSF program has experienced design and weight problems that, if not solved, will affect aircraft performance. These problems have led to increased development and procurement costs and schedule delays so far. In addition, the program's customers are still not sure how many aircraft they will need. The combination of cost overruns and quantity reductions has already diluted DOD's buying power and made the original JSF business case unexecutable. Given continuing program uncertainties, DOD could use more time right now to gain knowledge before it commits to a new business case for its substantial remaining investments. The JSF's current acquisition strategy does not embrace evolutionary, knowledge-based techniques intended to reduce risks. Key decisions, like the planned 2007 production decision, are expected to occur before critical knowledge is captured. Time taken now to gain knowledge will avoid placing sizable investments in production capabilities at risk to expensive changes.

Taken together, the current status and continuing risk in these two programs have broader implications to the DOD tactical fixed-wing aircraft modernization program, raising questions as to whether its overarching goals are now achievable. Decreases in quantities alone—about 30 percent since original plans—raise questions about how well the aircraft will complement our tactical air forces in the future.

Background

The F/A-22 aircraft program is acquiring the Air Force's next generation, multimission fighter for about \$63.8 billion.³ The continued need for the F/A-22, its increasing costs, and the quantities required to perform its

³This amount consists of \$61.3 billion currently budgeted for the basic program and the initial stages of the modernization efforts, \$1.3 billion for future start-up costs of a separate acquisition program for the latter stages of modernization, and \$1.2 billion in costs to retrofit aircraft with enhanced capabilities and activate depot maintenance activities.

mission have been the subject of a continuing debate within DOD and Congress. Supporters cite the F/A-22's advanced features—stealth, supercruise speed, maneuverability, and integrated avionics—as integral to the Air Force's Global Strike initiative and for maintaining air superiority over potential future adversaries for years to come.⁴ Critics, on the other hand, argue that the Soviet threat the F/A-22 was originally designed to counter no longer exists and that its remaining budget dollars could better be invested in enhancing current air assets and acquiring new and more transformational capabilities that will allow it to meet evolving threats. The debate continues as a December 2004 budget decision by the Office of the Secretary of Defense (OSD) reduced F/A-22 funding and the number of aircraft to be acquired. A full-rate production decision is expected in early April, but the Air Force already has 98 aircraft on contract.⁵

The JSF program is DOD's most costly aircraft acquisition program. The program's goals are to develop and field more than 2,400 stealthy strike fighter aircraft for the Navy, Air Force, and Marine Corps and potentially several hundred more aircraft for U.S. allies. International participation in the development of this system is a vital part of the acquisition strategy. The JSF is intended to provide greater capability and to replace DOD's aging fighter and attack aircraft. DOD estimates that the total cost to develop and procure its fleet of aircraft will reach \$245 billion, with total costs to maintain and operate the JSF adding another \$344 billion over its life cycle. Since the program began in November 1996, it has experienced technical challenges that have resulted in significant cost increases and schedule overruns. During most of 2004, the program worked to understand and define current development risks in order to prepare more accurate cost and delivery estimates to support development and production investment decisions planned over the next 2 years.

A key to successful acquisition programs is the development of a business case that should match requirements with resources—proven technologies, sufficient engineering capabilities, time, and funding—when

⁴Global Strike is one of six complementary concepts of operations laying out the Air Force's ability to rapidly plan and deliver limited-duration and extended attacks against targets.

⁵The Defense Acquisition Board met in late March of this year to discuss the F/A-22's progress and readiness for full-rate production. A final decision by the milestone decision authority is expected in early April.

undertaking a new product development. First, the user's needs must be accurately defined, alternative approaches to satisfying these needs must be properly analyzed, and quantities needed for the chosen system must be well understood. The developed product must be producible at a cost that matches the users' expectations and budgetary resources. Finally, the developer must have the resources to design and deliver the product with the features that the customer wants and to deliver it when it is needed. If the financial, material, and intellectual resources to develop the product are not available, a program incurs substantial risk in moving forward.

A New Business Case Is Needed to Justify Continued Investment in the F/A-22 Program

Since its inception in 1986, the F/A-22 aircraft program has encountered numerous and continuing management and technical challenges. Changing threats, missions, and requirements have severely weakened the original business case. Program milestones have slipped substantially; development costs have more than doubled; and a modernization program was added. The recent budget decision to terminate procurement after fiscal year 2008, the prospect of additional cuts because of ceilings on program cost, and upcoming defense reviews have significant implications for the program's viability and the future of modernization efforts.

In March 2004, we reported that the significant changes in the F/A-22's cost, quantity, capabilities, and mission and the persistent problems and delays in its development and testing schedules called for a new business case to justify the continued need for the F/A-22.⁶ We recommended that OSD direct the Air Force to consider alternatives and examine the constraints of future defense spending. In subsequent testimony, we reiterated this position, stating that competing priorities—both internal and external to DOD's budget—require a sound and sustainable business case for DOD's acquisition programs based on comprehensive needs assessments and a thorough analysis of available resources.⁷ In response to our recommendation, DOD stated its routine budgeting processes annually addressed business case issues on the F/A-22. We disagreed, as we do not think those processes provide the breadth or depth of analysis needed to develop a comprehensive new business case.

⁶GAO, *Tactical Aircraft: Changing Conditions Drive Need for New F/A-22 Business Case*, GAO-04-391 (Washington, D.C.: Mar. 15, 2004).

⁷GAO, *Tactical Aircraft: Status of the F/A-22 and Joint Strike Fighter Programs*, GAO-04-597T (Washington, D.C.: Mar. 25, 2004).

Problems in the F/A-22 Program Strain Future Viability

When initiated, the F/A-22 acquisition program planned to complete development in 1995, achieve initial operational capability by March 1996, and ultimately procure 750 aircraft. The Air Force currently plans to complete system development in 2005, achieve initial operational capability by December 2005, and procure 178 aircraft.

Amidst concerns about escalating costs and schedule, the Congress placed cost limitations on both development and production budgets in 1997,⁸ later removing the development cost cap.⁹ According to the Air Force, the current production cost cap is \$37.3 billion. Affordability concerns have, in part, led to the steady decrease in procurement quantities. Two major reviews of defense force structure and acquisition plans—the 1993 Bottom-Up Review and the 1997 Quadrennial Defense Review (QDR)—significantly reduced F/A-22 quantities. OSD’s “buy to budget” acquisition strategy essentially placed a ceiling on total program costs resulting in reducing quantities, and in December 2004, Program Budget Decision 753 reduced F/A-22 funding by \$10.5 billion, further reducing in all likelihood procurement quantities from 275 to 178 aircraft.¹⁰ The December 2004 budget decision also ended procurement in fiscal year 2008, instead of fiscal year 2011.

Decreased procurement quantities, along with increased development and production costs and increased costs to modernize and enhance capability, have led to rising acquisition unit costs. Figure 1 illustrates the downward trend in procurement quantities and the upward trend in program acquisition unit costs.¹¹

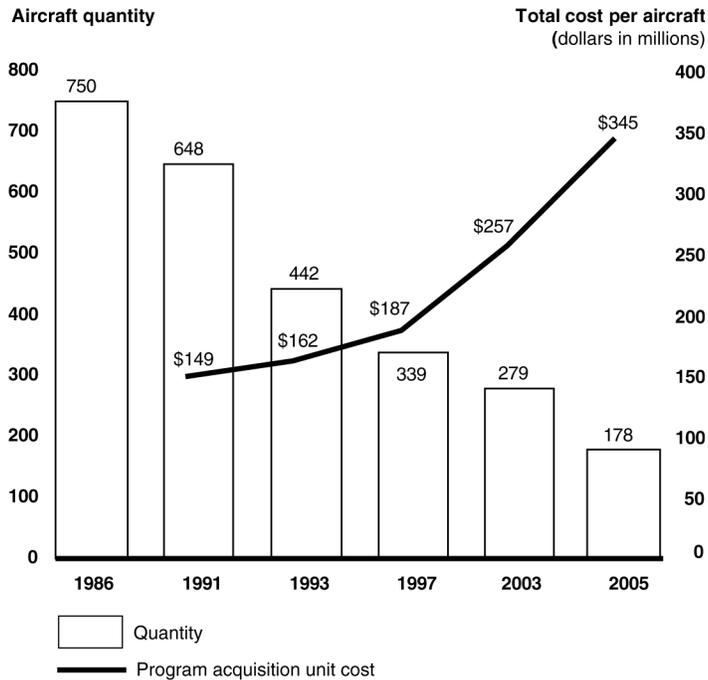
⁸Pub. L. No. 105-85 (Nov. 18, 1997), section 217.

⁹Pub. L. No. 107-107 (Dec. 28, 2001), section 213.

¹⁰Program Budget Decision 753 nominally reduced the procurement quantity to 179 aircraft. Subsequently, the Air Force transferred one aircraft to be used as a permanent test bed, reducing the procurement quantity to 178. The recent crash of an F/A-22 has reduced planned operational aircraft to 177.

¹¹Program acquisition unit cost includes funding for development, procurement, related military construction, and initial modernization divided by total production quantity. It does not include later stage modernization costs and certain support costs.

Figure 1: Quantity and Program Acquisition Unit Cost of F/A-22s



Source: U.S. Air Force (data); GAO (presentation).

In arguing for reversal of the December 2004 budget decision to stop procurement of the F/A-22 in 2008, Air Force officials noted that the decision obviates production economies and efficiencies that the Air Force expected to achieve through a multiyear procurement contract that was to begin in fiscal year 2008. Officials also stated that cutting production quantities from the final years of the program limits expected savings in annual unit procurement costs. As with many DOD acquisitions, Air Force program officials had assumed in future budgets that the costs for buying F/A-22s would decrease as a result of manufacturing efficiencies, reduced fixed costs, productivity projects, and more economical buying quantities. For example, the average unit flyaway cost for the F/A-22 in 2003 was about \$178 million, while the unit flyaway costs for future annual buys were projected before the budget decision to decrease to \$127 million, \$111 million, and \$108 million in fiscal years

2007, 2008, and 2009 respectively.¹² Now that the program will be truncated in 2008, the less expensive aircraft in 2009 and beyond will not be bought and unit costs are now projected at \$135 million in 2007 and \$149 million in 2008 (increases associated with close-out of production).

The F/A-22 program changes have also resulted in schedule delays for completing development testing, operational testing, and, consequently, the full-rate production decision. That decision is currently expected later this month but could slip again given the unsettled environment. One critical input to the decision is the report by the Office of the Director of Operational Test and Evaluation to the Congress and defense leadership on the adequacy and results of the recently completed initial operational test and evaluation.¹³ In addition, the F/A-22 program must demonstrate it satisfies criteria established by the Defense Acquisition Board in November 2004, which include delivering a fully resourced plan for follow-on testing to correct deficiencies identified in initial operational testing and evaluation, achieving design stability of the avionics software, demonstrating mature manufacturing processes, and validating technical order data.¹⁴

Final reports detailing the results from initial operational testing and evaluation were not available for our review, but Air Force test officials told us that testing showed the F/A-22 was “overwhelmingly effective” as an air superiority fighter and that its supporting systems were “potentially suitable” pending the correction of identified deficiencies. Operational testing of the limited ground attack capability in the current design was not conducted but is scheduled during follow-on testing planned to start in

¹²Average unit flyaway cost includes the costs associated with procuring one aircraft, including the airframe, engines, avionics, other mission equipment, and certain nonrecurring production costs. It does not include “sunk” costs for development and test and other costs to the whole system, including logistical support and construction.

¹³Statute 10 U.S.C. 2399 provides that a major defense acquisition program may not proceed beyond low-rate initial production until initial operational test and evaluation is completed and the congressional defense committees have received the report of testing results from the Director of Operational Test and Evaluation. This report is to contain an opinion of test adequacy and whether the test results confirm that the system actually tested is operationally effective and suitable for combat.

¹⁴The F/A-22 initial operational test and evaluation was conducted by the Air Force Operational Test and Evaluation Center from April through December 2004 to support the full-rate production decision. Its operational test plan was designed to assess the F/A-22's combat effectiveness and suitability in an operationally representative environment.

July 2005.¹⁵ Air Force officials believe that test results support approval of full-rate production. They also believe that deficiencies identified in aircraft reliability and maintainability (including maintaining low observable characteristics) and in the integrated diagnostic systems are readily correctible and the aircraft should meet the needs of the warfighter by the scheduled initial operational capability date in December 2005. However, whether the Air Force can accomplish all of this by December 2005 remains to be seen.

Future of Modernization Plans in Doubt

Originally, the F/A-22 was intended to replace the F-15 and achieve air-to-air superiority to counter large numbers of advanced Soviet fighters in conventional warfare. However, over the 19 years that the aircraft has been in development, the projected Cold War threats never materialized and new threats emerged, changing tactical fighter requirements and operational war plans. The Air Force now plans to implement a Global Strike concept of operations by developing a robust air-to-ground attack capability to allow the aircraft to counter a greater variety of targets, such as surface-to-air missiles systems, that pose a significant threat to U.S. aircraft. It also plans to equip most of the F/A-22 fleet with improved capabilities to satisfy expanded warfighter requirements and to take on new missions, including intelligence data gathering and the suppression of enemy air defenses and interdiction.

To implement its Global Strike concept, the Air Force established a time-phased modernization program. Table 1 shows how the Air Force intended to integrate new capabilities incrementally before the December 2004 budget decision reduced quantities by 96 aircraft. At the time of our review, officials were still determining the impacts of the budget decision on the modernization program content and quantities.

¹⁵Air-to-ground attack capabilities are increasingly emphasized by the Air Force, and future enhancements are planned for 80 percent of the modernized F/A-22s. More robust ground attack and intelligence gathering capabilities will be tested in the future as they are developed.

Table 1: Planned Modernization Enhancements for the F/A-22 Program

	Fiscal year when enhancements are expected to be incorporated			
	2007	2011 ^a	2013	2015
Capabilities increment	Global Strike Basic	Global Strike Enhanced	Global Strike Full	Enhanced Intelligence, Surveillance, and Reconnaissance
Configuration ^b	Block 20	Block 30	Block 40	Block 40
Quantity of F/A-22s	56	91	128	- ^c
Examples of enhancements to be added	Improve capability to launch Joint Direct Attack Munition at faster speeds and at longer distances; upgrade air-to-air capabilities	Enhance air-to-ground capability by adding improved radar capabilities to seek and destroy advanced surface-to-air missile systems; integrate additional air-to-ground weapons	Increase capability to suppress or destroy the full range of air defenses and improve speed and accuracy of targeting	Add capability for full intelligence, surveillance, and reconnaissance integration for increased target sets and lethality

Sources: Air Force and Office of Secretary of Defense.

^aGlobal Strike Enhanced includes two increments of capability, with the first increment incorporated in fiscal year 2009 and the second in 2011.

^bThe Air Force planned to have three configurations (called blocks) that included specific enhancements developed in the modernization program.

^cThis quantity included in Global Strike Full amount. Total 128 aircraft planned for block 40.

In March 2003, OSD’s Cost Analysis Improvement Group (CAIG) estimated that the Air Force would need \$11.7 billion for the planned modernization programs through fiscal year 2018.¹⁶ The Air Force’s latest estimate includes about \$4.1 billion through fiscal year 2011 for the first two modernization increments (blocks 20 and 30) and about \$1.3 billion through fiscal year 2011 for the latter two increments (block 40). The Air Force will continue to manage blocks 20 and 30 as part of the F/A-22 acquisition program. To manage block 40 efforts, OSD has directed the Air Force to establish a separate modernization program.¹⁷ Future modernization costs beyond 2011 have not been fully definitized and are

¹⁶The OSD CAIG acts as the principal advisory body to the milestone decision authority on program cost. The CAIG estimate included costs for development, procurement, and retrofit of modernized aircraft.

¹⁷In November 2004, the acting Under Secretary of Defense for Acquisition, Technology and Logistics directed the Air Force to hold separate milestone reviews for the latter stages of the modernization program to be consistent with DOD acquisition policy. The Air Force plans to manage these efforts as a separate acquisition program.

subject to change. The modernization program manager projected annual funding of \$700 to \$750 million would be needed for the currently planned modernization program after 2011.

The December 2004 budget decision places much of the modernization program in doubt, particularly the latter stages. This is because that decision terminated F/A-22 procurement after fiscal year 2008 and many of these new and advanced capabilities had been planned for aircraft that now will not be bought. Therefore, if the budget cut is sustained, the modernization program as currently planned is largely obsolete and some funding for advanced capabilities planned to be incorporated after fiscal year 2008 could be available for other uses. At the time of our review, Air Force officials were still restructuring the modernization program in response to the budget decision, including revising the desired mix of capabilities and the number of aircraft in each configuration. With the reduced quantity, they are considering having only two configurations, with the second incorporating some enhancements originally planned for the third configuration.

The budget decision causes a ripple effect on other resource plans tied to the modernization. For example, it brings into question the need for (1) upgrades to the computer architecture and processors estimated to cost between \$400 million and \$500 million; (2) upgrades to government laboratory and test range infrastructure like software avionics integration labs, flying test beds, and test ranges estimated to cost about \$1.8 billion; and (3) changes in other activities supporting modernization enhancements in the production line, retrofit of aircraft, and establishing depot maintenance support estimated at more than \$1.6 billion.

New JSF Business Case and Acquisition Strategy Is Critical for Program Success

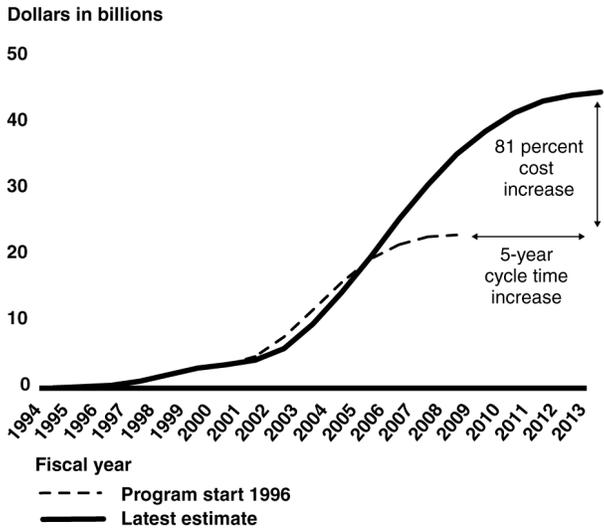
Unlike the F/A-22 program, which is near the end of development, the JSF program is approaching key investment decisions that will greatly influence the efficiency of the remaining funding—over 90 percent of the \$245 billion estimated total program costs—and determine the risk DOD is willing to accept. DOD has not been able to deliver on its initial promise, and the sizable investment greatly raises the stakes to meet future promises. Given continuing program uncertainties, DOD could use more time to gain knowledge before it commits to a new business case and moves forward. Any new business case must be accompanied by an acquisition strategy that adopts an evolutionary approach to product development—one that enables knowledge-based decisions to maximize the return on remaining dollars—as dictated by best practices.

DOD Needs More Time to Develop a New JSF Business Case

Increased program costs, delayed schedules, and reduced quantities have diluted DOD's buying power and made the original JSF business case unexecutable. Program instability at this time makes the development of a new and viable business case difficult to prepare. The cost estimate to fully develop the JSF has increased by more than 80 percent. Development costs were originally estimated at roughly \$25 billion. By the 2001 system development decision, these costs increased almost \$10 billion, and by 2004, costs increased an additional \$10 billion, pushing total development cost estimates to nearly \$45 billion. Current estimates for the program acquisition unit cost are about \$100 million, a 23 percent increase since 2001. Ongoing OSD cost reviews could result in further increases to the estimated program cost. At the same time, procurement quantities have been reduced by 535 aircraft and the delivery of operational aircraft has been delayed. Figure 2 shows how costs, quantities, and schedules have changed since first estimates based on data as of January 2005.

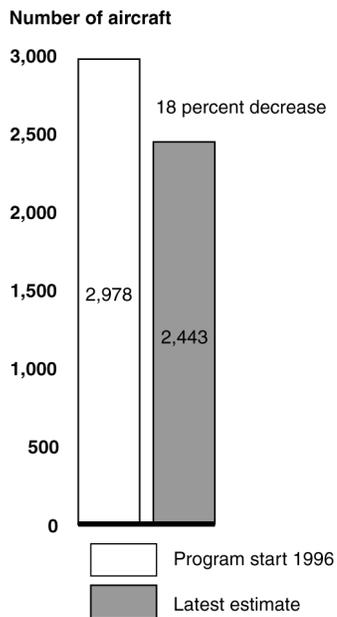
Figure 2: Measures of JSF Cost and Schedule Changes

Development costs and cycle time have increased



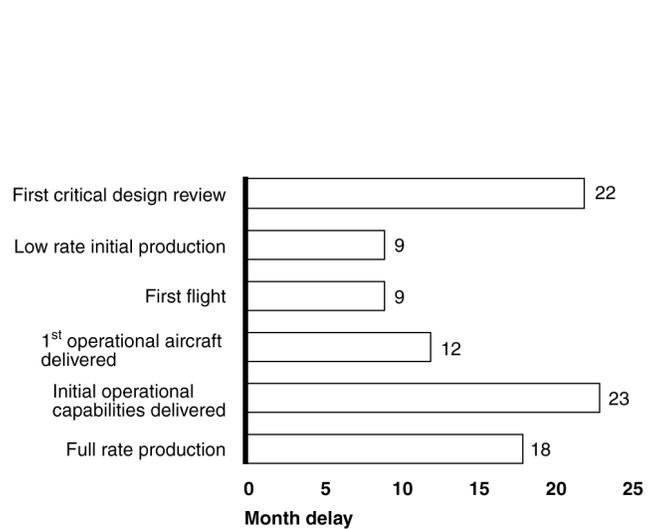
Source: GAO analysis of DOD data.

Procurement quantities have decreased



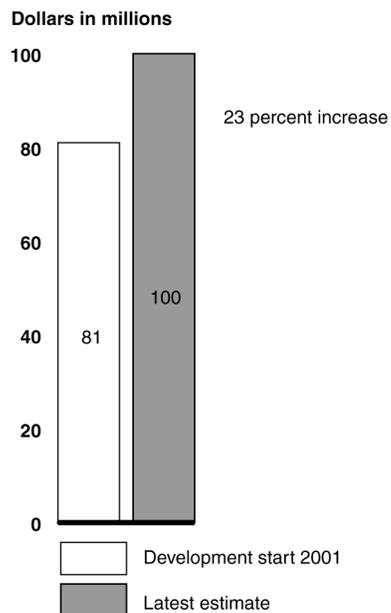
Source: GAO analysis of DOD data.

Key events delayed since development start in 2001



Source: GAO analysis of DOD data.

Total program acquisition unit costs have increased



Source: GAO analysis of DOD data.

Ongoing program uncertainties—including uncertainties about the aircraft's design and procurement quantities—make it difficult to understand what capabilities can be delivered with future investments. For example, DOD has been working over the past year to restructure the JSF program to accommodate changes in the aircraft's design; until this restructuring is completed, it will be difficult to accurately estimate program costs. The need for design changes largely resulted from the increased weight of the short takeoff and vertical landing variant and the impact it was having on key performance parameters. The other JSF variants' designs were affected as well. The program plans to have a more comprehensive cost estimate in the spring of 2005. However, a detailed assessment has not been conducted to determine the impact that the restructured program will have on meeting performance specifications. Until the detailed design efforts are complete—after the critical design review in February 2006—the program will have difficulty assessing the impact of the design changes on performance. While the program office anticipates that recent design changes will allow the aircraft to meet key performance parameters, it will not know with certainty if the weight problems have been resolved until after the plane is manufactured and weighed in mid-2007.

Program officials are also examining ways to reduce program requirements while keeping cost and schedules constant. Design and software teams have found greater complexity and less efficiency as they develop the 17 million lines of software needed for the system. Program analysis indicated that some aircraft capabilities will have to be deferred to stay within cost and schedule constraints. As a result, the program office is working with the warfighters to determine what capabilities could be deferred to later in the development program or to follow-on development efforts while still meeting the warfighter's basic needs. It may be some time before DOD knows when and what capabilities it will be able to deliver. The content and schedule of the planned 7-year, 10,000-hour flight test program is also being examined. According to the program office, the test program was already considered aggressive, and recent program changes have only increased the risks of completing it on time.

Finally, uncertainty about the number and mix of variants the services plan to purchase will also affect JSF's acquisition plans. While the Air Force has announced its intention to acquire the short takeoff and vertical-landing variant, it has yet to announce when or how many it expects to buy or how this purchase will affect the quantity of the conventional takeoff and landing variant it plans to buy. The number and mix of JSF variants that the Navy and Marine Corps intend to purchase—and their

related procurement costs—also remain undetermined. Foreign partners have expressed intent to buy about 700 aircraft between 2012 and 2015, but no formal agreements have been signed at this time. The 2005 Quadrennial Defense Review—an examination of U.S. defense needs—could also affect the procurement quantities and schedule. In developing a reliable business case, knowing the quantities to be purchased is equally as important as other elements. Without knowing types and quantities the program manager cannot accurately estimate costs or plan for production.

Timely Capture of Product Knowledge Needed to Support Future Business Decisions

In recent years, DOD has revised its weapons acquisition policy to support an evolutionary, knowledge-based strategy based on best practices—key to executing a future business case and making more informed business decisions.¹⁸ With an evolutionary acquisition approach, new products are developed in increments based on available resources. Design elements that are not currently achievable are planned for and managed as separate acquisitions in future generations of the product with separate milestones, costs, and schedules. While JSF's acquisition strategy calls for initially delivering a small number of aircraft with limited capabilities, the program has committed to deliver the full capability by the end of system development and demonstration in 2013 within an established cost and schedule for a single increment, contrary to an evolutionary approach.

In addition, JSF's planned approach will not capture adequate knowledge about technologies, design, and manufacturing processes for investment decisions at key investment junctures. Our past work has shown that to ensure successful program outcomes, a high level of demonstrated knowledge must be attained at three key junctures for each increment in the program. Table 2 compares best practice and JSF knowledge expectations at each critical point.

¹⁸DOD Directive 5000.1, *The Defense Acquisition System* (May 2003); DOD Instruction 5000.2, *Operation of the Defense Acquisition System* (May 2003). The directive establishes evolutionary acquisition strategies as the preferred approach to satisfying DOD's operational needs. The directive also requires program managers to provide knowledge about key aspects of a system at key points in the acquisition process.

Table 2: Knowledge Attainment on JSF Program at Critical Junctures

Best practice	Knowledge point 1	Knowledge point 2	Knowledge point 3
	Should be achieved at development start.	Should be achieved by the design review.	Should be achieved by the start of production.
	Separate technology and product development, deliver mature technology, and have preliminary design based on systems engineering principles.	Completion of 90 percent of engineering drawing packages for structures and systems, critical design review completed, and design prototyped.	100 percent of critical manufacturing processes under statistical control, demonstration of a fully integrated product in its operational environment to show it will work as intended, and reliability goals demonstrated.
JSF practice	Knowledge point 1 was not attained at milestone B in 2001.	Knowledge point 2 will not be attained by design review in 2006 under current plan.	Knowledge point 3 will not be attained by start of production in 2007 under current plan.
	Failed to separate technology and product development. Critical technologies not mature and sound preliminary design not established. Several technologies not expected to be mature until after production begins.	The program estimates 35 percent of the engineering drawing packages are expected to be released at the critical design reviews. Also, prototype testing will not be done prior to the design review. The design will not be stable until after production begins.	Program does not expect to demonstrate that the critical processes are under statistical control until 2009. Program expects to demonstrate that a fully integrated aircraft will work as intended and meets reliability goals in 2010-2012 timeframe.

Source: GAO data and analysis of DOD data

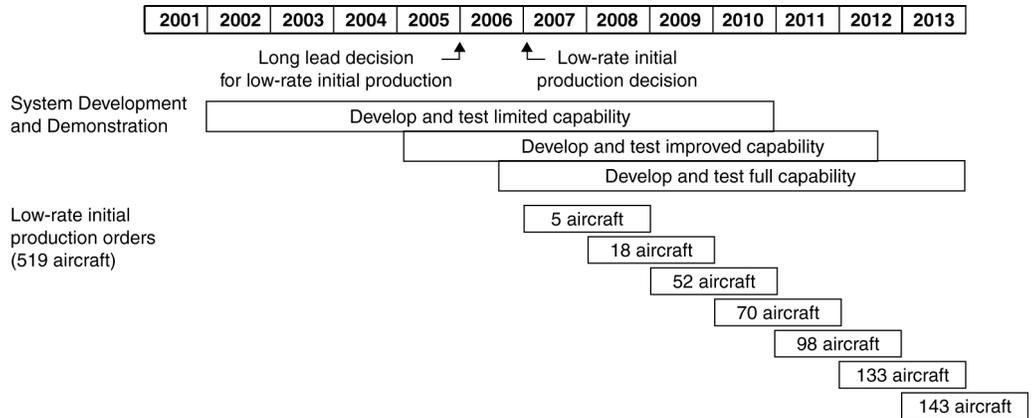
As shown in table 2, the JSF program will lack critical production knowledge when it plans to enter low-rate initial production in 2007. The department has included about \$152.4 million in its fiscal year 2006 budget request to begin long lead funding for low-rate initial production. This production decision is critical, and the knowledge required to be captured by knowledge point 3 in our best practice model should be achieved before this critical juncture is reached. If production begins without knowledge that the design is mature, critical manufacturing processes are under control, and reliability is demonstrated, costly changes to the design and manufacturing processes can occur, driving up costs and delaying delivery of the needed capability to the warfighter. The size of the potential risk is illustrated in the production ramp-up and investments planned after this decision is made. Between 2007 (the start of low-rate production) and 2013 (the scheduled start of full-rate production) DOD plans to buy nearly 500 JSF aircraft—20 percent of its planned total buys—at a cost of roughly \$50 billion. Under the program’s preliminary plan, DOD expects to increase low-rate production from 5 aircraft a year to 143 aircraft a year, significantly increasing the financial investment after

production begins.¹⁹ Between 2007 and 2009, the program plans to increase low-rate production spending from about \$100 million a month to more than \$500 million a month, and before development has ended and an integrated aircraft has undergone operational evaluations, DOD expects to spend nearly \$1 billion a month.

To achieve its production rate, the program will invest significantly in tooling, facilities, and personnel. According to contractor officials, an additional \$1.2 billion in tooling alone would be needed to ramp up the production rate to 143 aircraft a year. Over half of this increase would be needed by 2009—more than 2 years before operational flight testing begins. Figure 3 shows the planned production ramp up, along with the concurrently planned development program for the JSF.

¹⁹The preliminary plan was what was being considered at the time of our review. Since then, in its fiscal year 2006 budget submission, DOD has reduced the planned procurement quantities for the U.S. by 38 aircraft through fiscal year 2011. This includes planned quantities for the United Kingdom of 2 aircraft in fiscal year 2009, 4 aircraft in fiscal year 2010; 9 aircraft in fiscal year 2011, 9 aircraft in fiscal year 2012, and 10 aircraft in fiscal year 2013.

Figure 3: Overlap of JSF Low-Rate Production and System Development and Demonstration Activities (Includes U.S. and U.K. Quantities)



Source: GAO analysis of DOD data.

Following are examples of technology, design, and production knowledge that should be but will not be captured when the low-rate production decision is scheduled to be made.

- Only one of JSF's eight critical technologies is expected to be demonstrated in an operational environment by the 2007 production decision.
- Only about 40 percent of the 17 million lines of code needed for the system's software will have been released, and complex software needed to integrate the advanced mission systems is not scheduled for release until about 2010—3 years after JSF is scheduled to enter production. Further, most structural fatigue testing and radar cross section testing of full-up test articles are not planned to be completed until 2010.
- The program will not demonstrate that critical manufacturing processes are in statistical control, and flight testing of a fully configured and integrated JSF (with critical mission systems and prognostics technologies) is not scheduled until 2011.

Further, because of the risk created by the extreme overlap of development and production, the program office plans to place initial production orders on a cost reimbursement contract, placing a higher cost risk burden on the government than is normal. These contracts provide for payment of allowable incurred costs, to the extent prescribed in the contract. They are used when uncertainties involved in contract

performance do not permit costs to be estimated with sufficient accuracy to use any type of fixed-price contract and place greater cost risk on the buyer—in this case, DOD. In the case of the JSF, a fixed-price contract will not be possible until late in the development program.

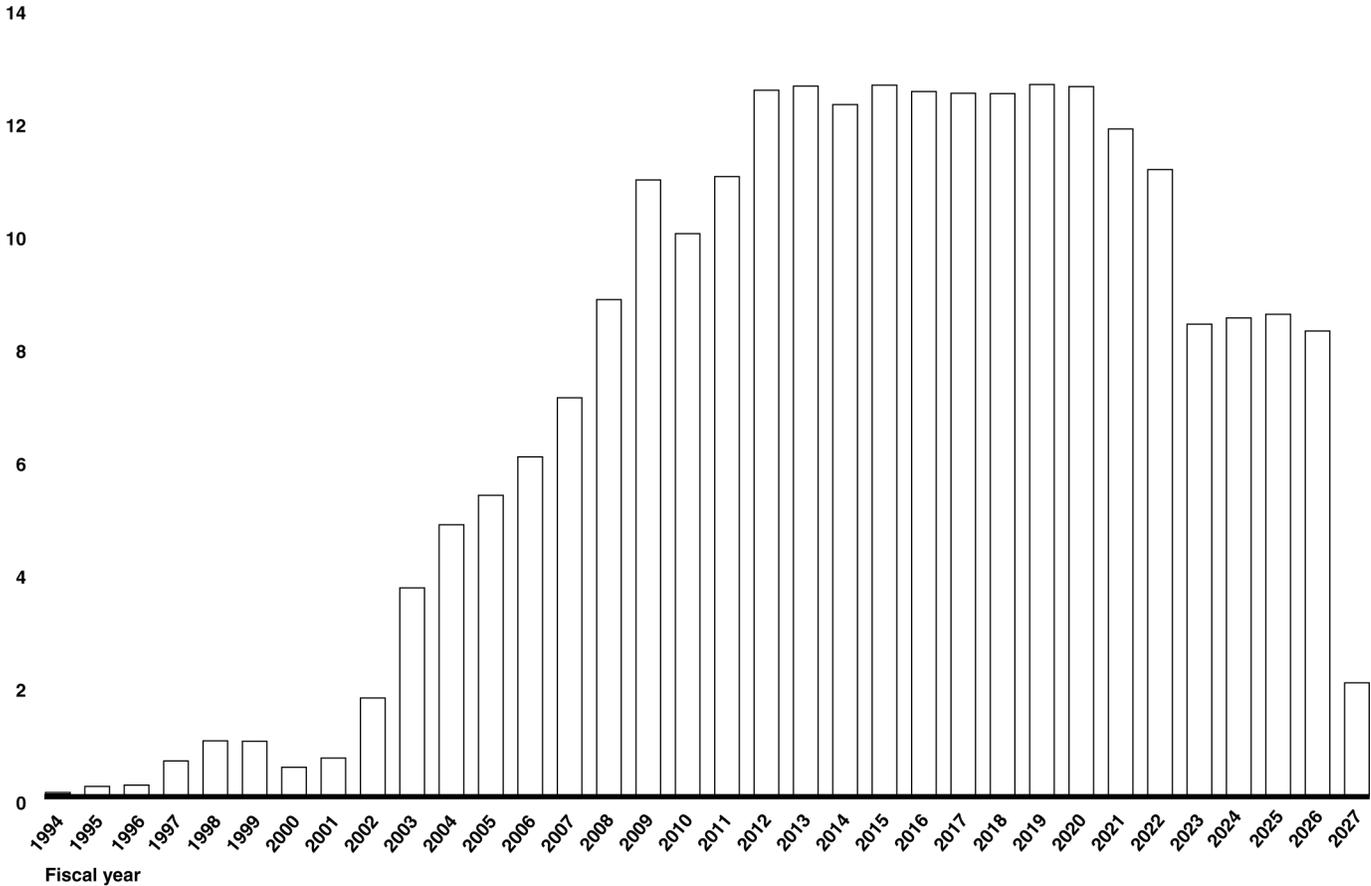
JSF's Substantial Funding Requirements May Be Difficult to Sustain in the Current Fiscal Environment

Regardless of likely increases in program costs, the sizable continued investment in JSF must be viewed within the context of the fiscal imbalance facing the nation over the next 10 years. The JSF program will have to compete with many other large defense programs as well as other priorities external to DOD's budget. JSF's acquisition strategy assumes an unprecedented \$225 billion in funding over the next 22 years or an average of \$10 billion a year (see fig. 4).²⁰

²⁰This is based on DOD's December 2003 JSF cost estimate.

Figure 4: JSF Program's Annual Funding Requirements (as of December 2003)

Dollars in billions



Source: GAO analysis of DOD data.

Funding challenges will be even greater if the program fails to stay within current cost and schedule estimates. For example, we estimate that another 1-year delay in JSF development would cost \$4 billion to \$5 billion based on current and expected development spending rates. A 10-percent increase in production costs would amount to \$20 billion.

Implications for the Current Status of Tactical Aircraft Programs

Continuing changes and uncertainties in the F/A-22 and JSF programs present significant challenges to DOD in achieving its modernization plans which attempt to blend many factors within affordability constraints. Factors in the decision making process can include aircraft age, ownership costs, readiness, force structure, operating concepts, competing needs, available funds, defense policy, and others.²¹ Today, both F/A-22 and JSF programs include significantly fewer aircraft than originally planned—30 percent fewer or over 1,000 aircraft. Deliveries intended to provide an operational capability have also been delayed in both programs, almost 10 years in the case of the F/A-22, requiring legacy systems to operate longer than planned. As legacy tactical aircraft age and near the end of their useful life, they require ever increasing investments to keep them ready and capable as the threat evolves—the cost of ownership.

The reduced F/A-22 force size, now fewer than 180 F/A-22 aircraft instead of 750 aircraft planned at the start of the program, could affect the Air Force's force structure and employment strategy. The Air Force still maintains it has a nominal requirement for 381 aircraft to meet its new Air and Space Expeditionary Forces—the operational mechanism through which the Air Force allocates forces to meet the combatant commanders' force rotation requirements—and Global Strike concept of operations. The Air Force planned on 10 F/A-22 squadrons to support this operational concept. Using the Air Force's normal methods for calculating force requirements, only about 110 aircraft of the total aircraft procured would be classified as available for combat and assignment to operational units²²—yielding only 4 or 5 typical fighter squadrons for assigning across the planned 10 air and space expeditionary units. The reduced fleet size may require the Air Force to consider the F/A-22 as a low-density/high-demand asset, which would require changes in these expected management and employment strategies. It also has implications for related resources and plans, including military personnel requirements, numbers of operating locations, support equipment, spare parts, and logistical support mechanisms.

²¹GAO, *Tactical Aircraft: Modernization Plans Will Not Reduce Average Age of Aircraft*, [GAO-01-163](#) (Washington, D.C.: Feb. 9, 2001). Today acquisition plans include 3,083 aircraft (F/A-22, FA-18EF, and JSF). The Air Force has been discussing buying fewer JSF, which would further lower the amount of planned new tactical aircraft.

²²The remaining aircraft are used for training and development activities and to account for aircraft in for maintenance and those held in reserve for normal attrition.

Other factors will come to play in the 2005 Quadrennial Defense Review. OSD has directed the review to include an assessment of joint air dominance in future warfare and the contributions provided by all tactical aircraft. An announced defense policy goal is to redirect investment from areas of conventional warfare, where the United States enjoys a strong combat advantage, toward more transformational capabilities needed to counter “irregular” threats, such as the insurgency in Iraq and the ongoing war on terror. DOD is also conducting a set of joint capability reviews to ensure acquisition decisions are based on providing integrated capabilities rather than focused on individual weapons systems. The study results, although still months away, could further affect the future of the F/A-22 and JSF programs including the F/A-22’s modernization plan. In these analyses, the new tactical aircraft will also have to compete for funding, priority, and mission assignments with operational systems, such as the F-15 and F/A-18, and other future systems, such as the Joint Unmanned Combat Air Systems.

The 2005 Quadrennial Defense Review provides an opportunity for DOD to assess tactical fixed-wing aircraft modernization plans and weigh options for accomplishing its specific as well as overarching tactical aircraft goals. It is critical that their investment be well-managed and balanced against DOD’s other priorities. Through the review, DOD can seek answers to overall investment strategy questions:

- What is the role of tactical aircraft in relation to other defense capabilities?
- Will planned investments in tactical aircraft allow DOD to achieve these capabilities and overall transformational goals?
- Where disconnects exist between goals and expected investment outcomes, what are the impacts and how will DOD compensate to minimize future security and investment risks?

If DOD fails to answer these questions and continues with its current modernization strategy, it will likely arrive in the future with needs similar to those that exist today but with fewer options and resources to resolve those needs. As DOD evaluates its tactical aircraft investment alternatives, knowledge at the program level is needed to understand how the F/A-22 and JSF can help achieve overall tactical aircraft modernization goals. More specific questions need to be answered for these programs including:

- Is the F/A-22 the most cost-effective alternative to fill gaps in ground attack and intelligence-gathering requirements?

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- How many F/A-22s are needed and affordable to carry out the aircraft's original mission, air superiority, and new ground attack and intelligence gathering missions?
 - If requirements for the new F/A-22 capabilities are legitimate and not solvable by other means, does the Air Force have the resources (mature technologies, design knowledge, time, and money) to begin investments in a new development program for the F/A-22 enhancements?
 - What is the immediate need for JSF aircraft? Delivery of its ultimate capability or replacing aging aircraft with an initial capability? Does the acquisition plan satisfy this need?
 - Does the program have the required knowledge about needed quantities and capabilities and resources (mature technologies, design knowledge, time, and money) to develop a reliable business case at this time?
 - Does DOD have the right acquisition strategy to develop and produce a JSF that will maximize its return on the more than \$220 billion investment that remains in this program?

While the JSF program started off with a higher-risk approach by starting system development with immature technologies, now is the time to implement an evolutionary and knowledge-based acquisition strategy to manage the system development phase and stabilize the design before making large investments in tooling, labor, and facilities to test and manufacture the aircraft. The JSF is relatively early in its system development and demonstration phase and has an opportunity to learn from the F/A-22 program experience. It must take the time needed now to gather knowledge needed to resolve key issues that could ultimately result in additional cost increases, delays, and performance problems.

Our March 2005 reports on the F/A-22 and JSF made recommendations to the Secretary of Defense that would require answering some of these questions before making significant additional investments. For the F/A-22, we recommended that a new business case be made to justify investments in new capabilities and the quantities needed to satisfy mission requirements. For the JSF, we recommended the establishment of an executable program consistent with policy and best practices, including an affordable first increment with its own business case, and the implementation of a knowledge-based acquisition approach to guide future investments and reduce risks.

Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions that you or other members of the Subcommittee may have.

Contacts and Staff Acknowledgments

For future questions about our work on the F/A-22 or JSF, please call me or Michael J. Hazard at (202) 512-4841. Other individuals making key contributions to this statement include Michael W. Aiken, Marvin E. Bonner, Lily J. Chin, Matthew T. Drerup, Bruce D. Fairbairn, Steven M. Hunter, Matthew B. Lea, David R. Schilling, and Adam Vodraska.

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