United States Government Accountability Office

GAO

Report to the Committee on Armed Services, U.S. Senate

March 2006

UNMANNED AIRCRAFT SYSTEMS

New DOD Programs Can Learn from Past Efforts to Craft Better and Less Risky Acquisition Strategies

GAO-06-447

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GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-06-447, a report to the Committee on Armed Services, U.S. Senate

Why GAO Did This Study

Through 2011, the Department of Defense (DOD) plans to spend $20 billion to significantly increase its inventory of unmanned aircraft systems, which are providing new intelligence, surveillance, reconnaissance, and strike capabilities to U.S. combat forces—including those in Iraq and Afghanistan.

Despite their success on the battlefield, DOD's unmanned aircraft programs have experienced cost and schedule overruns and performance shortfalls. Given the sizable planned investment in these systems, GAO was asked to review DOD's three largest unmanned aircraft programs in terms of cost. Specifically, GAO assessed the Global Hawk and Predator programs' acquisition strategies and identified lessons from these two programs that can be applied to the Joint Unmanned Combat Air Systems (J-UCAS) program, the next generation of unmanned aircraft.

What GAO Recommends

GAO recommends that DOD (1) limit Global Hawk production until the program demonstrates an integrated system and develops a new business case to justify future investments and (2) develop a sound business case and acquisition strategy for J-UCAS and follow-on efforts to ensure cost and schedule goals are met. DOD did not concur with our Global Hawk recommendations because it believes it is taking appropriate measures to manage risk.

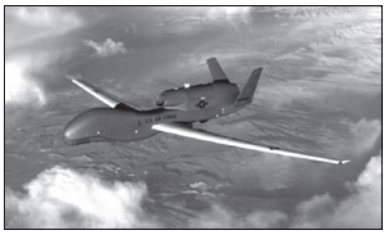
www.gao.gov/cgi-bin/getrpt?GAO-06-447.

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

While the Global Hawk and Predator both began as successful demonstration programs, they adopted different acquisition strategies that have led to different outcomes. With substantial overlap in development, testing, and production, the Global Hawk program has experienced serious cost, schedule, and performance problems. As a result, since the approved start of system development, planned quantities of the Global Hawk have decreased 19 percent, and acquisition unit costs have increased 75 percent. In contrast, the Predator program adopted a more structured acquisition strategy that uses an incremental, or evolutionary, approach to development—an approach more consistent with DOD's revised acquisition policy preferences and commercial best practices. While the Predator program has experienced some problems, the program's cost growth and schedule delays have been relatively minor, and testing of prototypes in operational environments has already begun.

Since its inception as a joint program in 2003, the J-UCAS program has experienced funding cuts and leadership changes, and the recent Quadrennial Defense Review has directed another restructuring into a Navy program to develop a carrier-based unmanned combat air system. Regardless of these setbacks and the program's future organization, DOD still has the opportunity to learn from the lessons of the Global Hawk and Predator programs. Until DOD develops the knowledge needed to prepare solid and feasible business cases to support the acquisition of J-UCAS and other advanced unmanned aircraft systems, it will continue to risk cost and schedule overruns and delaying fielding capabilities to the warfighter.



Global Hawk	Predator
Sought quantum leap in capabilities	Incremental development of capabilities
Design relied on unproven technologies	Design relied more on proven technologies
Significant overlap of technology development, design, testing, and production	Moderate overlap of testing and production
Risk tolerant leadership	Strong direction to follow defense acquisition policy preferences
Funding optimistic and compressed in a few years	Funding realistic and balanced over time

Sources: Northrop Grumman Corporation and General Atomics-Aeronautical Systems, Inc. (pictures). GAO analysis of DOD program data.

Contents

Abbreviations

ACTD	advanced concept technology demonstration
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
J-UCAS	Joint Unmanned Combat Air Systems
OSD	Office of the Secretary of Defense

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United States Government Accountability Office
Washington, DC 20548

March 15, 2006

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

Through 2011, the Department of Defense (DOD) plans to spend $20 billion to develop, procure, and support a rapidly increasing inventory of unmanned aircraft systems.[1] Unmanned aircraft systems are providing combat forces—including those in Iraq and Afghanistan—with new intelligence, surveillance, reconnaissance, and strike capabilities that are helping to transform today's military operations. The success of unmanned aircraft has led to greatly increased demand for new and improved platforms to be deployed into the field. While there have been successes on the battlefield, the development of unmanned aircraft systems has shared the same problems as other major weapon systems that begin an acquisition program too early, with many uncertainties about requirements, technology, design, and production. Likewise, the unmanned systems have also experienced similar outcomes—changing requirements, cost growth, delays in delivery, and reliability and support problems.

Because of the expanding interest and promise in unmanned systems and sizable future investments, you asked us to review the Global Hawk, Predator, and Joint Unmanned Combat Air Systems—DOD's three largest unmanned aircraft programs in terms of cost. Specifically, you asked us to (1) assess the Global Hawk and Predator programs' business cases and acquisition strategies in terms of delivering their weapon systems on time and within cost, and (2) identify any lessons that can be learned and applied to the Joint Unmanned Combat Air Systems (J-UCAS) program as

[1] Until recently, DOD referred to these aircraft as "unmanned aerial vehicles." The terms "unmanned aircraft" and "unmanned aircraft systems" are consistent with the Federal Aviation Administration's classification and emphasizes that the aircraft is one component of the weapon system, which also includes payloads, ground stations, and communications equipment.

it moves forward to develop a supportable business case and effective acquisition strategy.[2]

To assess these two objectives, we reviewed Global Hawk and Predator acquisition strategies and business cases and evaluated them according to best practices criteria utilizing GAO's Methodology for Assessing Risks on Major Weapons System Acquisition Programs. We assessed budget, programmatic, and planning documents to determine the extent to which acquisition strategies were meeting warfighter requirements. We identified lessons learned from these and other programs and identified common factors that can contribute to J-UCAS's success. We interviewed DOD and contractor officials and obtained programmatic data for these three systems. We leveraged prior work on other systems and on best practices of leading companies. We performed our review from August 2005 to February 2006 in accordance with generally accepted government auditing standards.

Results in Brief

The Global Hawk and Predator programs followed different acquisition strategies that resulted in different outcomes. While both programs began with top leadership support and accomplished successful, focused demonstration efforts, Global Hawk switched to a high-risk acquisition strategy by accelerating development and production of a new larger and more advanced aircraft. With the substantial overlap in development and production, the program experienced significant gaps in knowledge about technology, design, and manufacturing capabilities while requiring sizable funding. As a result, serious cost and schedule problems have ensued, some required capabilities have been deferred or dropped, operational tests have identified performance problems, and the Global Hawk program is being restructured. In contrast, the Predator program, which has also added a new, larger and more advanced aircraft, has pursued an acquisition strategy that is more structured and evolutionary and more consistent with DOD's revised acquisition guidance and commercial best practices. While the Predator effort to acquire its larger model also has overlap in development and production and has experienced some problems, cost growth and schedule delays to date have been more moderate than those of Global Hawk, and flight testing of prototypes in operational environments has already begun.

[2] The committee also asked us to review the Army's Extended Range/Multi-Purpose unmanned aircraft system, which we will report on separately.

The J-UCAS program and its offspring could benefit from the lessons learned in the Global Hawk and Predator programs. Since its inception, the J-UCAS program has been in flux. Program management and goals have changed several times, and the recent Quadrennial Defense Review has directed another restructuring into a Navy program to demonstrate a carrier-based, air-refuelable unmanned combat air system. The Air Force plans to consider J-UCAS technologies and accomplishments in its efforts to develop a new long-range strike capability. Before DOD commits to major acquisition system development programs, it has the opportunity and time to develop the knowledge needed to prepare solid and feasible business cases and to adopt a disciplined, evolutionary strategy consistent with DOD acquisition policy preferences and best practices.

We are recommending that the Secretary of Defense direct the Air Force to limit the production of Global Hawk B aircraft until integrated systems are demonstrated in testing and that the Global Hawk office update its business case to reflect the restructured program and justify future investments. We are also recommending that the Secretary direct the Navy and Air Force to advance with prudence in J-UCAS and follow-on efforts to ensure a sound business case and evolutionary, knowledge-based strategy guide any future programs and that the services remain committed to developing common components and operating systems to be more cost-effective and interoperable. DOD concurred with our J-UCAS recommendations, but did not concur with our Global Hawk recommendations. DOD stated that limiting Global Hawk production will incur significant costs and schedule delays, that risk and concurrency are being adequately managed, and that ongoing cost and evaluation efforts are thorough. We continue to believe that limiting Global Hawk procurement to allow technology to mature and thorough testing to occur will reduce future problems and lead to better program outcomes. Given the magnitude of changes and challenges facing the program, we also believe a comprehensive business case to justify and guide investments is needed.

Background

DOD expects unmanned aircraft systems to transform the battlespace with innovative tactics, techniques, and procedures and take on the so-called "dull, dirty, and dangerous missions" without putting pilots in harm's way. The use of unmanned aircraft systems in military operations has increased rapidly since the fall of 2001, with some notable successes. Potential missions considered appropriate for unmanned systems have expanded from the original focus on the intelligence, surveillance, and reconnaissance mission area to limited tactical strike capabilities with

projected plans for persistent ground attack, electronic warfare, and suppression of enemy air defenses. The Global Hawk, Predator, and Joint Unmanned Combat Air Systems are DOD's three largest unmanned aircraft programs in terms of cost. (For more details on the three systems and their performance characteristics, see app. I.)

Since the terror attacks in September 2001, defense investments in unmanned aircraft systems have exponentially increased. In the 10 years prior to the attacks, DOD invested a total of about $3.6 billion compared to the nearly $24 billion it plans to invest in the subsequent 10 years. DOD currently has about 250 unmanned aircraft in inventory and plans to increase its inventory to 675 by 2010 and to 1,400 by 2015. (These numbers are the larger systems and do not count numerous small and hand-launched systems used by ground forces.)

In the fiscal year 2001 Defense Authorization Act, Congress set a goal that by 2010, one-third of DOD's deep strike force will be unmanned in order to perform this dangerous mission;[3] this would significantly increase the number of unmanned aircraft in DOD's inventory. In addition, foreign countries and other federal agencies, including the Department of Homeland Security and the Interior Department, are expressing interest in unmanned aircraft systems. Table 1 shows the funding in the fiscal year 2006 Defense budget for research, development, procurement, and support of current and planned unmanned aircraft systems.

Table 1: Defense Budget Requests for Unmanned Aircraft Systems

(in millions of dollars by year of appropriation)								
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
Development and procurement	$1,998.5	$1,670.3	$1,734.8	$1,983.8	$2,550.0	$2,643.4	$2,771.1	**$15,351.9**
Operations[a]	$167.3	$275.4	$338.7	$265.6	$295.4	$308.6	$342.0	**$1,993.0**
Basic and applied research[b]								**$2,553.0**
Total	**$2,165.8**	**$1,945.7**	**$2,073.5**	**$2,249.4**	**$2,845.4**	**$2,952.0**	**$3,113.1**	**$19,897.9**

Source: "Unmanned Aircraft Systems Roadmap 2005-2030," Office of the Secretary of Defense.

[a]Does not include 2005 supplemental funding for combat operations.

[b]Annual breakdown of basic and applied research funding is not provided.

[3] Pub. L. No. 106-398, Appendix H.R. 5408, sec. 220 (2000).

The 2006 Quadrennial Defense Review contained a number of decisions that would further expand investments in unmanned systems and their use in military operations. The report states DOD's intent to nearly double unmanned aircraft coverage by accelerating the acquisition of the Predator and the Global Hawk. It also restructures the J-UCAS program to develop an unmanned, long-range carrier-based aircraft to increase naval reach and persistence. It further establishes a plan to develop a new land-based, penetrating long-range strike capability by 2018 and sets a goal that about 45 percent of the future long-range strike force be unmanned. Officials told us that elements of the J-UCAS effort will be considered in Air Force analyses and efforts supporting future long-range strike capability.

Best Practices for Achieving Successful Acquisition Outcomes

Unmanned aircraft systems are being developed under DOD's acquisition policy, which emphasizes a knowledge-based, evolutionary approach to acquiring major weapon systems. This approach separates technology development from product development, as suggested by best practices. In implementing the policy, a critical first step to success is formulating a comprehensive business case that justifies the investment decision to begin development. The business case should validate warfighter needs and match product requirements to available resources, including proven technologies, sufficient engineering capabilities, adequate time, and adequate funds. Several basic factors are critical to establishing a sound business case for undertaking a new product development. First, the user's needs must be accurately defined, alternative approaches to satisfying these needs 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 the product with the features that the customer wants and to deliver it when it is needed. If circumstances substantially change, the business case should be revisited and revised as appropriate. If the financial, material, and intellectual resources to develop the product are not available, a program should not move forward.

Best practices indicate that the business case is best accomplished using an evolutionary (or incremental) approach that plans to deliver an early but relevant capability first, followed by definable and doable increments that ultimately achieve the full capability. Each increment is expected to have its own decision milestones and baseline—cost, schedule, and performance requirements. An acquisition strategy is the disciplined process employed by the service program office and prime contractor to manage the acquisition, deliver knowledge at key junctures to make

further investments, and continue the program. The strategy implements the business case; sets schedules for developing, designing, and producing the weapon system; and establishes exit/entrance criteria to guide acquisition managers and executives through key program milestones to control and oversee the acquisition.

Global Hawk and Predator Had Common Beginnings, but Different Acquisition Strategies Have Yielded Different Outcomes

While the Global Hawk and Predator both began as successful advanced concept technology demonstration (ACTD) programs, they have since adopted different strategies in system development that have led to different outcomes. The Global Hawk adopted a riskier acquisition strategy that has led to significant cost, schedule, and performance problems. Conversely, the Predator program pursued a more structured and evolutionary strategy more consistent with DOD's acquisition policy guidance and has thus far experienced fewer negative outcomes.

Global Hawk Program Has Experienced Relatively Poor Outcomes

Following a successful ACTD, DOD approved an acquisition program in 2001 to incrementally develop and acquire systems similar to the demonstrators, now designated the RQ-4A (Global Hawk A). In 2002, the Global Hawk program was substantially restructured to more quickly develop and field a new, larger, and more advanced aircraft, designated the RQ-4B (Global Hawk B). The new acquisition strategy was now highly concurrent, overlapping technology development, design, testing, and production. Our November 2004 report on Global Hawk, raised concerns about the revised strategy and its elevated risks of poor cost, schedule, and performance outcomes. [4] We recommended limiting procurement to only those aircraft needed for testing to allow product knowledge to more fully mature and the design and technologies to be tested before committing resources to the full program. DOD officials did not agree because, in their opinion, we overstated some risks and they were effectively mitigating other risks.

The Global Hawk program is already experiencing problems that are associated with high concurrency and gaps in product knowledge. Production of the larger Global Hawk B aircraft began in July 2004 with

[4] GAO, *Unmanned Aerial Vehicles: Changes in Global Hawk's Acquisition Strategy Are Needed to Reduce Program Risks*, GAO-05-6 (Washington, D.C.: Nov. 5, 2004).

immature technologies and an unstable design. The design had been expected to be very similar to the smaller Global Hawk A, whose performance had been proven in the ACTD, but as the larger aircraft design matured and production geared up, the differences were more extensive, complex, and costly than anticipated. Within a year, there were more than 2,000 authorized engineering drawing changes to the total baseline of 1,400 drawings, and more than half were considered major changes. Also, once manufacturing began, there were recurring quality and performance issues on the work of several key subcontractors. The subcontractor building the tail scrapped seven of the first eight main structural components because of design changes and manufacturing process deficiencies. The wing manufacturer had to terminate a key subcontractor because of poor performance and quality. Other suppliers delivered parts late and with defects. These specific problems have mostly been resolved, but the potential for even greater problems exists when the major subsystems, still in development, are integrated into the new larger aircraft already being produced.

Outcomes so far have not been good, as the program has experienced significant cost increases. Extensive design changes contributed to a $209 million overrun in the development contract and resulted in a more expensive production aircraft than forecast. Requirements growth, increased costs of airframe and sensors, and increased support requirements significantly increased procurement costs. In April 2005, the Air Force reported to Congress a Nunn-McCurdy breach in procurement unit costs—an 18 percent increase over the program's cost baseline approved in 2002.[5] In December 2005, we reported the Air Force had failed to report $401 million in procurement costs and that the procurement unit cost had actually increased 31 percent.[6] Subsequently, in December 2005, the Air Force renotified Congress that, if these additional costs were included, the procurement unit costs had actually increased by over 25 percent and that program acquisition unit costs (including development and military construction costs in addition to procurement) had also breached the thresholds established in the law. Under the law, DOD must

[5] To provide for oversight of cost growth in DOD major defense acquisition programs, Congress passed legislation in 1982, commonly referred to as Nunn-McCurdy, that, as amended, requires DOD to notify Congress when a program's unit cost growth exceeds (or breaches) the latest approved acquisition program baseline by at least 15 percent. This requirement is codified at 10 U.S.C. 2433.

[6] GAO, *Unmanned Aircraft Systems: Global Hawk Unit Price Increases Understated in Nunn-McCurdy Report*, GAO-06-222R (Washington, D.C.: December 15, 2005).

now certify the program to Congress.[7] The Air Force is currently restructuring the Global Hawk program—the fourth restructuring since it began as a major acquisition.

Program schedules and performance have also been negatively affected. For example, the start of operational assessment of the Global Hawk A slipped about 1 year, and the planned start of initial operational testing of the Global Hawk B design has slipped 2 years. The Director, Operational Test and Evaluation, reports that operational assessment of the Global Hawk A identified significant deficiencies in processing and providing data to the warfighter, communication failures, and problems with engine performance at high altitudes. In addition, planned delivery dates have continued to slip, the procurement for two aircraft were moved to later years, and some development work content was deferred or deleted; this means that the warfighter will not get anticipated capability at the time originally promised. For example, defensive subsystems required by Air Combat Command have been pushed off the schedule, and it is not known whether they will be added in the future.

The frequent deployment of Global Hawk demonstrator aircraft to support combat operations has further affected costs and schedule, according to officials. Support to the warfighter is the program's top priority. Deployments have resulted in increased costs and time delays for acquisition but, at the same time, provide a valuable, realistic test for the system and its employment concepts to improve its performance and responsiveness to the warfighter. Fleet flying hours now exceed 8,000 hours, more than half in combat operations.

The following table shows changes in cost and quantities since the program started in March 2001. The restructured program tripled development costs, reflecting the addition of the new Global Hawk B aircraft with advanced capabilities still in technology development. Total procurement costs increased moderately, resulting from higher costs for the new aircraft tempered by a reduction in the number of aircraft to be acquired for reasons of affordability and changed requirements. Total program acquisition and procurement unit costs have increased 73 percent

[7] If the cost growth has increased at least 25 percent over the baseline, the Secretary of Defense must certify to Congress that (1) the program is essential to national security, (2) no alternatives exist which will provide equal or greater military capability at less cost, (3) new program acquisition or procurement unit cost estimates are reasonable, and (4) the management structure is adequate to control unit cost.

and 35 percent, respectively, and aircraft quantities decreased by 19 percent. Thus far, seven Global Hawk As have been delivered to the Air Force—14 percent of the combined fleet—and 34 percent of the planned budget to completion has been invested.

Table 2: Changes in Global Hawk Funding, Quantity, and Unit Costs through Completion of the Program

(in millions of base year 2006 dollars)				
Cost	**March 2001**	**January 2006**	**Changes**	**Percent**
Development	$925.2	$2,459.1	$1,533.9	166%
Procurement	$3,836.2	$4,197.5	$361.3	9%
Total	**$4,761.4**	**$6,656.6**	**$1,895.2**	**40%**
Quantity				
Aircraft	63	51	-12	-19%
Ground stations	14	10	-4	-29%
Unit Costs				
Total program	$75.6	$130.5	$54.9	73%
Procurement only	$60.9	$82.3	$21.4	35%

Source: DOD data, GAO analysis.

Note: Procurement costs include costs for aircraft, ground stations, support equipment, and spares. Military construction funding is not included.

Predator Program Has Had Better Outcomes than Global Hawk

The Predator program began in 1994 as an ACTD to demonstrate and deliver what would become the MQ-1 (Predator A). It evolved from an earlier unmanned aircraft, the Gnat, allowing delivery of an initial demonstrator aircraft to DOD 6 months after contract award. The Predator ACTD concluded in 1996 and transitioned to the Air Force in 1997 when the Defense Acquisition Board approved the Predator A for production. A limited strike capability, to launch Hellfire missiles against ground targets, was later added. On the basis of the success of the Predator A, the contractor designed and built two prototypes of a larger aircraft capable of armed reconnaissance and surveillance. This new aircraft would evolve into the second generation MQ-9 (Predator B), a larger and higher-flying aircraft with more strike capability. In February 2004, the Predator B program was approved as a new system development and demonstration

program. It is managed separately from Predator A and has its own schedule and management reviews.

The Predator program overall has experienced fewer cost, schedule, and performance problems than the Global Hawk program has experienced. As of February 2006, the Predator A program has a stable design with little cost growth and the Air Force recently increased its planned buys. Although early in the acquisition cycle, cost increases in the Predator B program have been moderate and schedule changes few. The fiscal year 2005 report of the Director, Operational Test and Evaluation, cited favorable developmental testing results and recommended refining acquisition and fielding strategies to permit more focused and effective operational testing. To date, about 59 percent of the combined fleet (as presented in last year's budget) has been delivered for about 56 percent of the current planned budget. Deliveries include 129 Predator As and 2 prototype and six production Predator Bs. The combined fleet has tallied 120,000 flight hours since 1995. Congress has been supportive of both Predators, typically adding to annual funding requests and quantities.

Table 3 summarizes changes in the Predator B program estimates to completion since its start of system development.

Table 3: Changes in Predator B Funding, Quantity, and Unit Costs through Completion of the Program

(in millions of base year 2006 dollars)				
Cost	**February 2004**	**January 2006**	**Changes**	**Percent**
Development	$153.6	$177.5	$23.9	16%
Procurement	$935.1	$1,031.9	$96.8	10%
Total	**$1,088.7**	**$1,209.4**	**$120.7**	**11%**
Quantity				
Aircraft	63	63	$0.0	0%
Unit Costs				
Total program	$17.3	$19.2	$1.9	11%
Procurement only	$14.8	$16.4	$1.5	10%

Source: DOD data, GAO analysis.

Note:. Procurement costs include costs for aircraft, ground stations, support equipment, and spares. Military construction funding is not included. Totals may not equal 100 because of rounding.

Differences in Global Hawk and Predator Business Practices Have Contributed to the Programs' Outcomes to Date

The Global Hawk and Predator began with top leadership support and successful demonstration efforts as ACTDs, but differences in their business practices have been the primary contributors to different cost, schedule, and performance outcomes so far in these programs. Both programs were under pressure to field capabilities quickly to support the warfighter. Original models of both systems have proven to be valuable assets in combat operations, and both transitioned from technology demonstrations into weapon system acquisition programs with sound strategies to complete development and acquire initial systems with enhanced capabilities. However, Global Hawk subsequently changed to a riskier acquisition strategy that plans to develop technologies concurrently with the system design, testing, and production phases of the program. Predator, while not immune to typical developmental problems, has pursued a more disciplined, structured approach intended to evolve new capability in separate programs. Its decisions have been more consistent with DOD's acquisition policy preferences. Table 5 shows some of the differences of the current programs that have led to greater success in the Predator program so far.

Table 4: Comparison of Business Case and Acquisition Strategy Factors in Current Global Hawk and Predator Programs

Acquisition factors	Global Hawk	Predator
Acquisition strategy	Quantum leap	Incremental
Technologies	Immature	Mostly mature
Concurrency	Significant overlap of technology development, design, testing, and production	Moderate overlap of technology development, testing, and production
Leadership	Less directive and more risk-tolerant	Direction to follow acquisition policy preferences
Funding	Optimistic and compressed into a few years	Moderate and balanced over time

Source: GAO analysis of DOD program data.

Global Hawk's Acquisition Strategy Is More Risky than Predator's

The current Global Hawk acquisition strategy is risky. It plans to develop a new, larger, and more capable aircraft by integrating as yet undemonstrated technologies into a new airframe, also undemonstrated, to provide a quantum leap in performance over its ACTD. The Predator also added plans for a new, larger aircraft, but chose an incremental approach by managing the new investment in a separate program with separate decision points.

The Global Hawk program began in 1994 as an ACTD, managed first by the Defense Advanced Research Projects Agency and, since 1998, by the Air Force. Seven demonstrator aircraft were built, logged several thousand

flight hours, completed several demonstrations and other tests, and passed a military utility assessment. Demonstrators subsequently provided effective support to military operations in Iraq and Afghanistan. DOD judged the demonstration a success, but tests identified the need to make significant improvements in reliability, sensor performance, and communications before producing operationally effective and suitable systems.

In March 2001, DOD approved the Global Hawk for a combined start of system development and limited initial production of six aircraft. The Air Force's acquisition strategy approached best practices standards in terms of technology and design maturity. Officials planned to first acquire basic systems very similar to the successful demonstrators and then incrementally develop and acquire systems with more advanced sensors as critical technologies were demonstrated, using the same platform. Officials planned to acquire a total of 63 aircraft (Global Hawk As), and 14 ground stations for mission launch, recovery, and control. These aircraft would all be dedicated to single missions, some having imagery intelligence capabilities and others having signals intelligence capabilities.

In 2002, the Air Force radically restructured the Global Hawk program to develop and acquire a larger and more advanced aircraft system, the Global Hawk B. The decision to acquire the larger aircraft was driven by the desire to have multimission capabilities (both signals intelligence and imagery intelligence sensors on the same aircraft) and to deliver new capabilities associated with advanced signals intelligence and radar technologies still in development. The new acquisition strategy abandoned an incremental approach and moved toward a strategy that called for concurrent development of technologies, systems integration, testing, and production. The Air Force planned to set and approve requirements and mature technologies over time, instead of at the start of development, and to do this at the same time as it designed and produced the new larger and heavier aircraft that had never been built or flight-tested.

For affordability reasons and changing requirements, the restructured program also reduced quantities to 51 aircraft—7 Global Hawk As and 44 Global Hawk Bs—and 10 ground stations. Most of the Global Hawk Bs are planned to have multimission capabilities, including the advanced signals intelligence sensor, and some will have single-mission capabilities, including the advanced radar. Low-rate production was tripled from the 6 Global Hawk As approved at program start to 19 aircraft as restructured—7 Global Hawk As and 12 Global Hawk Bs—about 40 percent of the entire fleet. To speed up development and field these new capabilities sooner,

DOD also approved the program to streamline and accelerate acquisition processes, bypassing some normal acquisition policy requirements and controls when considered appropriate. For example, the Global Hawk B business case did not include a comprehensive analysis of alternatives that is intended to rigorously compare expected capabilities of a new system with the current capabilities offered by existing weapon systems, such as the signals intelligence capabilities provided by U-2 aircraft.

Although the program could have reduced cost and schedule risks by managing a series of discrete increments to develop and acquire the different configurations, the Air Force chose to manage it as one program, with one baseline and one set of decision milestones. This revised strategy attempts to deliver capability to the warfighter that significantly surpasses that of the former Global Hawk A program. And the Air Force has committed up-front to produce the larger Global Hawk B aircraft in order to deliver new capabilities to the warfighter sooner, but the signals intelligence sensor and advanced radar technologies critical to meeting requirements are still immature and are not expected to be delivered and integrated until very late in the program.

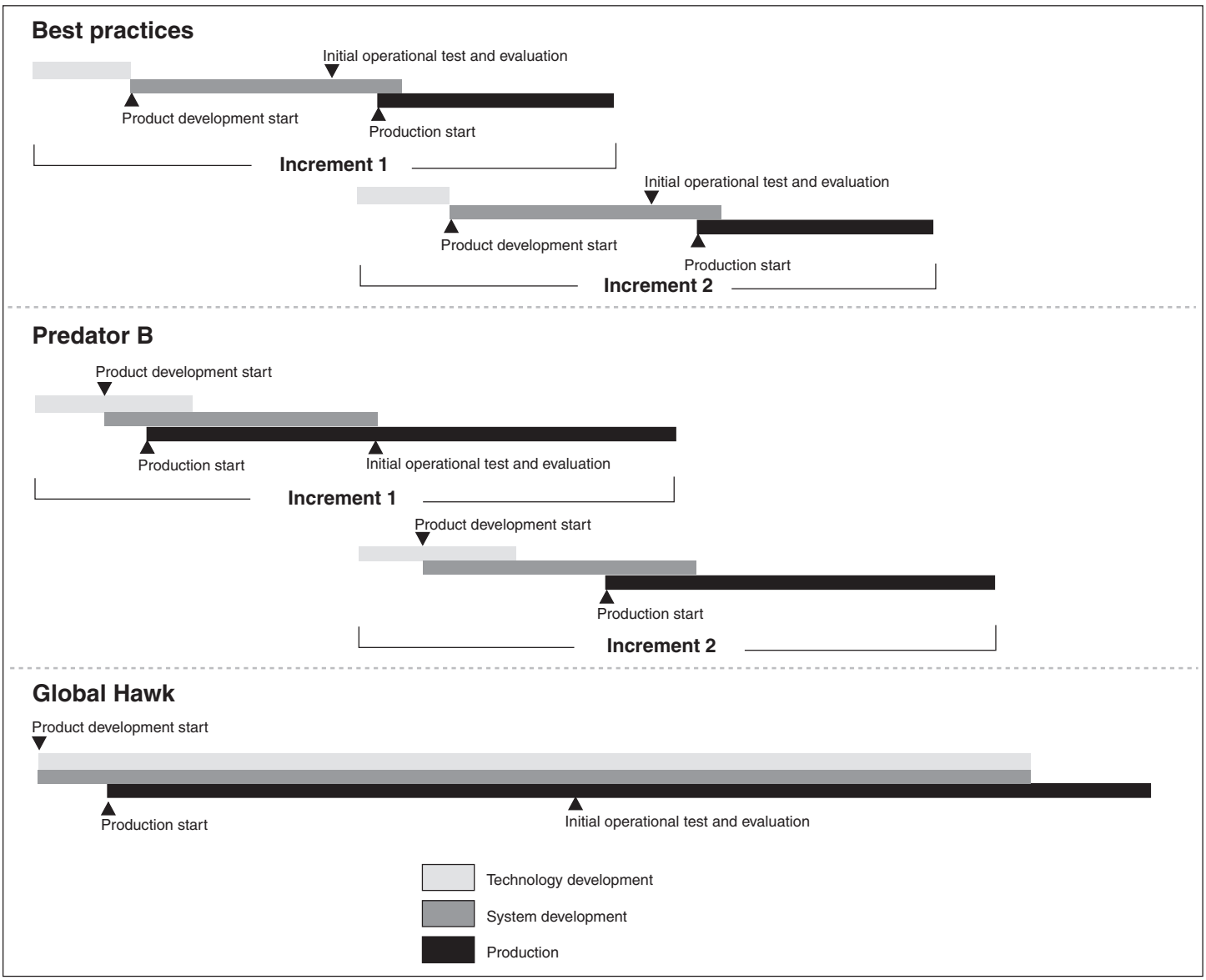
The Predator transitioned from its ACTD program in 1997, when the Defense Acquisition Board approved the Predator A for production, skipping the system development and design phases. The transition was not without difficulty because the focus during the demonstration effort had been to quickly ascertain operational capabilities, but without emphasis on design and development aspects that make a system more reliable and supportable—typically key aspects of a development program. The Air Force had to organize a team to respond to these issues until reliability and supportability issues could be resolved. Senior leadership, however, kept the strategy simple and focused on buying additional Predators very similar to the ACTD models.

In February 2004, the Predator B program was approved as a new system development and demonstration program. The Predator B program was approved without two fundamental elements of a good business case: formal requirements documentation and an analysis of alternatives. According to the Air Force, these were not prepared because of the exigencies of the Global War on Terror. Officials initially planned to adopt an acquisition strategy similar to the Global Hawk's, but senior leadership intervened and the acquisition strategy adopted was incremental and more consistent with DOD acquisition policy preferences. Under the revised strategy, the Air Force manages the Predator A and B acquisitions as separate programs. The new Predator B program balanced requirements

and resources for a first increment and included its own sets of milestone decision points. Subsequent increments will evolve when future requirements and resources can be matched.

Figure 1 contrasts notional Predator B and Global Hawk schedules for implementing their respective acquisition strategies with that espoused by best practices and DOD acquisition policy. Predator's incremental approach with less overlap of technology and system development is more similar to best practices.

Figure 1: Comparison of Predator B and Global Hawk Acquisition Plans with Best Practices Model



Source: DOD data, GAO analysis.

Global Hawk's Technologies Are Much Less Mature than Predator's

Critical technologies were not sufficiently mature to support the start-up of the Global Hawk B program—particularly those associated with the signals intelligence and advanced radar, the very capabilities that drove the decision to acquire the larger aircraft. Likewise, the larger and heavier

aircraft was neither prototyped nor demonstrated. The Predator B's technologies were mostly mature at program start, and the aircraft has been built and flown. Mature technologies can leverage the potential for success in development, providing early assurance that the warfighter's requirements can be met within cost and schedule goals.

Although Global Hawk A technologies were demonstrated in the ACTD, the level of technology maturity significantly declined when Global Hawk B was approved for development. In particular, the new signals intelligence and multiplatform radar systems were still in technology development, not expected to be mature and be tested in an operational environment until sometime between 2009 and 2011. The spillover of technology development into product development and overall immaturity of technology increase risks of poor cost, schedule, and performance outcomes. For example, as the advanced sensors mature and become ready to be integrated into the aircraft, there is risk that the aircraft, already being produced, will not have sufficient space, power, or cooling or that the sensor systems will weigh more than planned, reducing aircraft performance and ability to meet overall mission requirements—altitude, speed, and endurance.

Predator A has been in production since 1997 and its technologies are mature. All Predator B technologies, except for one, are mature. This one meets the DOD standard for maturity—demonstration in a lab environment—but has not yet met best practice standards that require demonstrations in an operational environment. This technology is important to manage the weapons that Predator B will carry and launch—more than those on Predator A. It relies on a data link that enables the operator to release the weapon from the ground. Program officials have stated that the current problems with this technology are related to its integration into the Predator B weapon system. In unmanned aircraft, unlike manned aircraft, there is no one in the cockpit to fire the weapon. To develop this capability required revisions to software, cryptologic controls, navigation sensors, and flight operations. The Air Force expects this capability to be demonstrated in an operational environment after it has been integrated into a Predator B in May 2006.

Global Hawk and Predator Both Include Concurrent Development and Production

The Global Hawk's restructured program includes a significant overlap of technology, design, and production. The Predator B program is also concurrent, but to a lesser degree. Concurrency—the overlapping of development, test, and production schedules—is risky and can be costly and delay delivery of a usable capability to the warfighter if testing shows design changes are necessary to achieve expected system performance.

Once in production, design changes can be an order of magnitude greater than changes identified during the design phase.

By requiring a larger air vehicle to carry new advanced technologies while speeding up the acquisition schedule, the Air Force accepted much higher risks than the original plan, which followed a more evolutionary approach. The Air Force restructured the Global Hawk program, extending the development period, delaying testing, and accelerating aircraft production and deliveries, resulting in substantial concurrency. The development period was expanded by 5 years, and production deliveries were accelerated and compressed to fewer years, creating significant overlap from fiscal years 2004 to 2010. As a result, the Air Force plans to buy almost half of the new larger Global Hawk aircraft before a production model is flight-tested and operational evaluations are completed to show that the air vehicle design works as required. Substantially more than half of the aircraft will be purchased before the airborne signals intelligence and multiplatform radar, the two technologies that are required for the larger aircraft, complete development and are integrated for flight testing.

The Predator B program's revised strategy also overlapped development and production. For example, 21 Predator aircraft will be purchased before initial operational test and evaluation has been completed. Air Force officials acknowledge that the concurrency will require them to modify about 10 of these aircraft to bring them up to the full first increment capability. Modifications will include the installation of the system to manage and launch weapons and the digital electronic engine controller.

Different Leadership Approaches Have Influenced Outcomes in Both Programs

Top management attention set the stage for the early success of Global Hawk. The Under Secretary of Defense for Acquisition, Technology, and Logistics became personally involved in establishing the original plan for development. Leadership insisted on fielding an initial capability that could be developed within a fixed budget while providing for an evolutionary process to add enhancements to succeeding versions. The result was a very successful ACTD program that produced seven demonstrators, logged several thousand flight hours, passed its military usefulness assessment, and has since very effectively supported combat operations in Afghanistan and Iraq. Once the Global Hawk was approved as a major acquisition program, however, senior Air Force leaders diverted Global Hawk to a high-risk spiral development strategy that featured frequent changes to development plans and time frames. They also approved the larger Global Hawk B with immature critical technologies

and a highly concurrent test and production program—much of this contrary to best practices and defense acquisition policy preferences.

The Predator also had top management attention early in the program and has maintained its high visibility through a high-ranking group of Air Force executives known as Task Force Arnold. Established in 2002 as a senior oversight body for the Predator, Task Force Arnold has provided guidance and headquarters-level direction to Air Combat Command on the needs and capabilities for the system. The group has played a valuable role in helping the Predator program maintain a tight focus on program requirements and direction. Once the Predator A became operational, Air Combat Command was besieged by requests from combatant commanders for additional enhancements or capabilities. To alleviate the problem, the task force acted as the arbiter for operational requirements. New capabilities had to be vetted and prioritized through the task force before they were incorporated. This kept a balance between requirements and available resources and reduced the burden on Air Combat Command and the program office, enabling the program to better manage its requirements.

The task force was instrumental in revising the Predator B plans and acquisition strategy. On the basis of an assessment from Task Force Arnold, the Secretary of the Air Force directed that the program office field an interim combat capability to balance an urgent operational need with new acquisition. The Secretary also directed that the program office revise its acquisition strategy to incrementally develop the Predator. Accordingly, the Air Force restructured the program, dropping the spiral development plan for an incremental approach. This strategy extended the production schedule by 5 years and delayed initial operating capability by 3 years—lessening the degree of concurrency and providing more time to mature technology and design. Whereas the original strategy called for procuring 8 operational aircraft by August 2005, the revised, more conservative strategy plans to acquire 6 aircraft delivered 1 year later.

Global Hawk Funding Requirements Are More Compressed than Those of the Predator

Global Hawk funding requirements are optimistic, have changed, and continue to increase. In 2002 Global Hawk tripled estimated development costs and compressed the procurement of aircraft into fewer years. Program funding, which previously had been allocated relatively evenly across 20 years, was compressed into roughly half the time, tripling Global Hawk's budgetary requirements in certain years. This adds to funding risk should large annual amounts be unaffordable as they compete with other defense priorities. The Air Force is currently preparing a new acquisition

baseline estimate, its fourth baseline since the program started in March 2001.

In contrast, Predator funding requirements are less optimistic and are spread over a longer production period. The stable Predator A program has been in production since 1997 and had been focused on replacing aircraft lost through attrition. However, the Air Force increased its buy quantities in the fiscal year 2007 budget to reflect increased future force requirements. The revised acquisition strategy for the Predator B extended the production period by 5 years and decreased annual buy quantities, resulting in more even and achievable levels of annual funding. Annual funding for both Predators has been increased by Congress in recent years, enabling the Air Force to procure additional Predator systems or make enhancements to the fielded systems.

J-UCAS Program Can Benefit from Lessons Learned by Global Hawk and Predator Programs

J-UCAS represents the next generation of unmanned aircraft. In addition to providing intelligence and surveillance capabilities, J-UCAS is being designed as a heavily weaponized and persistent strike aircraft. The joint Air Force and Navy technology demonstration combined the two services' separate efforts to develop early models of advanced unmanned attack systems. Since the pre-acquisition program was initiated in 2003, it has experienced funding cuts and leadership changes. The recent Quadrennial Defense Review calls for again restructuring the program into a Navy effort to demonstrate an unmanned carrier-based system. Regardless of future organization, DOD still has the opportunity to learn from the lessons of the Global Hawk and Predator programs to develop the knowledge needed to prepare solid and feasible business cases to support advanced unmanned aircraft acquisitions.

J-UCAS Plans and Acquisition Strategy Continue to Evolve

Before J-UCAS was established as a joint program, the Air Force and Navy had separate unmanned combat aircraft projects under way, each in partnership with the Defense Advanced Research Projects Agency (DARPA). In 2003, we reported that the Air Force's original business plan provided time to mature technologies and was a relatively low-risk approach, but that plans and strategy had changed to a much accelerated and higher-risk approach.[8] The new plan proposed to increase

[8] GAO, *Defense Acquisitions: Matching Resources with Requirements Is Key to the Unmanned Combat Air Vehicle Program's Success*, GAO-03-598 (Washington D.C.: June 30, 2003).

requirements and accelerate the schedule for development and production, substantially increasing concurrency of development, test, and production activities. The gaps in product knowledge and the unfinished technology development added significant risks of poor cost, schedule, and performance outcomes. Therefore, we supported DOD's decision, under discussion at the time of our review, which advocated a new joint service approach and which reduced risks by significantly slowing down the Air Force's plans.

DARPA was then designated to lead a joint demonstration program with Air Force and Navy participation. The joint office began operations in October 2003 and devised a $5 billion pre-acquisition program that would develop and demonstrate larger and more advanced versions of the original Air Force and Navy prototypes (three from each contractor for a total of six aircraft). The office planned to conduct an operational assessment starting in 2007 and use the results to inform Air Force and Navy decisions for possible system acquisition starts in 2010. The demonstrators were expected to meet both the Air Force and Navy requirements and to share a common operating system, sensors, and weapons. Compared with the revised Air Force plans, the joint approach provided a more knowledge-based strategy with decreased risks of poor outcomes. The joint strategy delayed the start of system development, providing more time to mature the technologies, incorporate new requirements, and conduct demonstrations with prototype aircraft.

In December 2004, the Office of the Secretary of Defense (OSD) reduced programmed funding by $1.1 billion and directed that funding and leadership be transitioned to the Air Force, with Navy participation, and that the joint program be restructured. The funding and leadership perturbations added about 19 months to the schedule for completing technology demonstration and deciding whether to start new system developments. The plan then was to develop and demonstrate five aircraft to inform system development decisions in fiscal year 2012.
Now it appears the J-UCAS program will change one more time as the 2006 Quadrennial Defense Review directed its restructuring into a Navy program to develop an unmanned longer-range carrier-based aircraft capable of being air-refueled to provide greater standoff capability, to expand payload and launch options, and to increase naval reach and persistence. The Quadrennial Defense Review also directed speeding up efforts to develop a new land-based, penetrating long-range capability to be fielded by 2018. The Air Force is expected to use the accomplishments and technologies from the restructured J-UCAS program to inform the upcoming analysis of alternatives for the next generation long range strike

program. The Air Force has a goal that approximately 45 percent of its future long-range strike force will be unmanned. Although the J-UCAS and follow-on efforts appear somewhat unstable as they go through these changes, we see benefits to this. Addition of requirements and changes in user needs can be determined prior to full program initiation. If done after an acquisition begins systems integration, these perturbations would be much more costly.

Lessons Learned

The Navy's restructured J-UCAS program, the Air Force's new long-range strike effort, and other future programs have opportunities to learn lessons from the Global Hawk and Predator programs. As originally envisioned, the J-UCAS demonstration effort provided for an extended period of time to define warfighter requirements, mature and demonstrate technologies, inform the design with systems engineering, and conduct a thorough operational assessment to prove concepts and military utility. These kinds of actions would establish a foundation for a comprehensive business case and effective acquisition strategy. Key lessons that can be applied to J-UCAS and its offspring include

- maintaining disciplined leadership support and direction similar to that experienced early in Global Hawk from the Under Secretary of Defense for Acquisition, Technology, and Logistics and with the Predator's Task Force Arnold;
- establishing a clear business case that constrains individual program requirements to match available resources based on proven technologies and engineering knowledge before committing to system development and demonstration;
- establishing an incremental acquisition strategy that separates technology development from product development and minimizes concurrency between testing and production;
- establishing and enforcing controls that require knowledge and demonstrations to ensure that appropriate knowledge is captured and used at critical decision junctures before moving programs forward and investing more money; and
- managing according to realistic funding requirements that fully resource product development and production based on a cost estimate that has been informed by proven technologies and a preliminary design.

Additionally, lessons of the Global Hawk and Predator transitions from ACTDs into production and operation are important. The advanced concept technology demonstration can be a valuable tool to prove

concepts and military utility before committing time and funds to a major system acquisition. However, designing in product reliability and producibility and making informed trade offs among alternative support approaches are key aspects of development. If these operational aspects of system development are not addressed early before production, they can have major negative impacts on life cycle costs.

Finally, as the J-UCAS evolves one more time—and efforts return to the individual services—some key challenges will exist to maintain the advantages that were offered by a joint effort. The services need to be aware of those advantages and not arbitrarily reject them for parochial reasons. For example, exploiting past plans for common operating systems, components, and payloads is important to affordability. Common systems offer potential for cost savings as well as improved interoperability. In particular, the common operating system pursued by DARPA is a cutting edge tool to integrate and provide for interoperability of air vehicles, allowing groups of unmanned aircraft to fly in a coordinated manner and function autonomously (without human input).

Conclusions

Global Hawk's high-risk acquisition strategy resulted in increased costs and delays. The restructured Global Hawk program is very different from the original program that was approved in 2001 for a combined start of development and limited production. The restructured program replaced the original strategy to slowly and incrementally develop and acquire enhanced versions of the proven demonstrator, with a highly concurrent and accelerated strategy to develop and acquire a substantially new aircraft with much advanced capabilities still in technology development. Despite these major changes, officials essentially overlaid the new plans on the old and did not prepare a comprehensive business case to support the larger aircraft and justify specific quantities of the advanced signals intelligence and advanced radar capabilities. Predator B's strategy is less risky, and as a result, the program has had moderate cost growth and has delivered assets in a timely manner.

There are trends that run consistently through the Global Hawk and Predator programs, similar to trends in other major defense acquisition programs that we have reviewed. That is, when DOD provides strong leadership at an appropriate organizational level, it enables innovative, evolutionary, and disciplined processes to work. Once leadership is removed or diminished, programs have tended to lose control of requirements and add technical and funding risks. We have also found that after successful demonstrations to quickly field systems with existing

technologies, problems were encountered after the programs transitioned into the system development phase of the acquisition process. The services pushed programs into production without maturing processes and also began to add new requirements that stretched beyond technology and design resources. Inadequate technology, design, and production knowledge increased risk and led to cost, schedule, and performance problems.

J-UCAS has had a bumpy road with several changes in leadership and strategic direction. However, J-UCAS and its offspring as directed by the Quadrennial Defense Review will be at a good juncture to establish a sound foundation for developing the business case and an effective acquisition strategy for follow-on investments by better defining warfighter needs and matching them with available resources. Refining requirements based on proven technologies and a feasible design based on systems engineering are best accomplished in the concept and technology development phase that precedes the start of a system acquisition program. During this early phase, the environment is conducive to changes in requirements that can be accomplished more cost-effectively than after systems integration begins and large organizations of engineers, suppliers, and manufacturers are formed to prepare for the start of system production.

Recommendations for Executive Action

We are making following recommendations to reduce program risk and increase the likelihood of more successful program outcomes by delivering capabilities to the warfighter when needed and within available resources. Specifically,

The Secretary of Defense should direct the Global Hawk program office to

- limit production of the Global Hawk B aircraft to the number needed for flight testing until the developer has demonstrated that signals intelligence and radar imagery subsystems can be integrated and perform as expected in the aircraft, and
- update business case elements to reflect the restructured program to include an analysis of alternatives, a justification for investments in the specific quantities needed for each type of Global Hawk Bs being procured (signals intelligence and advanced radar imagery), and a revised cost estimate.

The Secretary of Defense should direct the Navy and Air Force organizations responsible for the development efforts stemming from the

former J-UCAS program to not move into a weapon system acquisition program before

- determining requirements and balancing them to match proven technologies, a feasible design based on systems engineering by the developer, and available financial resources;
- developing an evolutionary and knowledge-based acquisition strategy that implements the intent of DOD acquisition policy; and
- establishing strong leadership empowered to carry out the strategy that will work in conjunction with the other services to ensure the design and development continue to incorporate commonality as initiated under the DARPA-managed joint program.

Agency Comments and Our Evaluation

DOD provided us with written comments on a draft of this report. The comments appear in appendix II. DOD concurred with our three recommendations on the J-UCAS, but did not concur with our two recommendations on the Global Hawk. Separately, DOD provided technical comments, which we incorporated where appropriate.

Regarding our recommendation to limit Global Hawk procurement, DOD stated that the program is managing risk and would test the signals intelligence sensor and advanced radar on other systems and transition them to Global Hawk when mature. DOD stated that our recommendation would stop the production line and incur significant cost and schedule delays.

We continue to believe that limiting further Global Hawk B procurement to units needed for testing until the aircraft and its advanced technologies are integrated and operationally evaluated will lead to better program outcomes. The Global Hawk program is experiencing significant cost, schedule, and performance problems, and reducing procurement should lessen future program risks and allow more time to mature and test the new aircraft design and technologies before committing funds for most of the fleet. No Global Hawk B aircraft has completed production yet and first flight is not expected until November 2006. Initial operational test and evaluation of the basic aircraft design with only imagery intelligence capabilities has slipped into fiscal year 2009. According to the Air Force's current budget plans, more than one-half of the total Global Hawk B fleet will have been purchased before starting initial operational test and evaluation. Schedules for follow-on operational tests of the aircraft integrated with the advanced signals intelligence and radar technologies—the capabilities that drove the decision to acquire the larger aircraft—have

also slipped. While we support Air Force efforts to first test these new capabilities on surrogate systems, our concern is again that, by the time the Air Force tests fully integrated Global Hawk systems in an operational environment, most of the aircraft will already be built or on order. If problems are revealed during testing of the aircraft and its technologies, they could require costly redesign and remanufacture of items already produced and further delay getting these capabilities to combatant commanders.

There are several other compelling reasons to limit procurement plans:

- Projected delivery dates for the Global Hawk B continue to slip. Estimated delivery schedules in the fiscal year 2007 budget show that deliveries have slipped an average of almost 10 months since Global Hawk B production started in July 2004 and by an average exceeding 6 months in the last year alone. If any further slippage occurs, production may be a year or more behind what the Air Force's strategy and financial plan was built upon. With these delays, the Air Force should be able to reduce near-term buys and rebalance subsequent procurements without materially affecting the flow of production.

- Procurement through fiscal year 2006 will complete its approved low-rate initial production quantity of 19 aircraft. By law, a major weapon system cannot proceed beyond the low-rate quantity until initial operational test and evaluation has been satisfactorily completed as reported by the Director, Operational Test and Evaluation. Again, initial operational test and evaluation has been delayed until fiscal year 2009. In his annual report, the Director stated that low-rate production quantities should not be increased on the Global Hawk until after an adequate initial operational test and evaluation of the Global Hawk B aircraft and ground segments.

- Operational assessment of the smaller Global Hawk A is not yet complete. Testing and flight operations have experienced engine shut-downs, communication failures, and imagery data processing deficiencies. These problems directly affect the Global Hawk B because it uses the same engine and similar communication and data processing systems.

Regarding our recommendation to update the Global Hawk's business case, DOD stated that the department's current Nunn-McCurdy certification evaluation and program rebaselining is thorough and provides

department leaders with the information they need to make informed decisions. Because the Nunn-McCurdy certification and rebaselining effort is ongoing, we cannot comment on whether these documents will make up a comprehensive business case. However, given the magnitude of the program's continuing changes and challenges discussed in this report, we are concerned that these efforts will fall short. A business case should be rigorously updated to reflect significant restructurings, to justify specific investments in new and emerging technologies, and to match revised requirements to available resources.

Our apprehension is not unfounded. In November 2004, we similarly recommended that DOD delay further procurement of the Global Hawk B until a new business case—one that reduced risk and applied a knowledge-based approach—was completed. DOD chose not to concur with this recommendation, arguing that the department was effectively mitigating risk. Despite DOD's assurances, events that triggered the Nunn-McCurdy review in April 2005 not only indicate that the risk mitigation measures were ineffective but underscore the wisdom of making a new business case. In addition to cost increases, schedule delays, and performance problems that have altered many of the program's conditions and plans as they were originally envisioned, officials said they are rethinking Global Hawk test plans and low-rate quantities, which could affect the elements on which a business case is made. Our past work on major weapon systems acquisitions has clearly shown the value of preparing and maintaining a comprehensive business case to justify and guide investments, and the need to revisit the business case if circumstances substantially change, as they have on Global Hawk.

Scope and Methodology

To determine the extent to which Global Hawk and Predator acquisition strategies and business cases were effective in meeting warfighter requirements we reviewed budget and planning documents. We also utilized GAO's Methodology for Assessing Risks on Major Weapon System Acquisition Programs to assess their acquisition strategies and business cases with respect to best practices criteria. The methodology is described from the best practices and experiences of leading commercial firms and successful defense acquisition programs. We interviewed DOD and contractor officials and obtained programmatic data and reports for the Global Hawk and Predator. We incorporated our recent Global Hawk and Predator Quick Look efforts and past GAO reports and testimony. We reviewed management plans, cost reports, progress briefings, and risk data to identify execution efforts and results to date.

The primary comparisons made in the report are for the most part focused on the combined Global Hawk program and the Predator B program. Information on the Predator A program mainly provides a historical perspective and lessons learned from that older and more mature system. We received DOD comments questioning whether the Global Hawk and Predator B programs can reasonably be compared given the differences in time frames; Global Hawk's system start was in March 2001, 3 years earlier than Predator B's start in February 2004.

While we agree that there may sometimes be a period of time before problems in a newer program become evident, we believe the two programs can be compared to provide valuable lessons for future acquisitions. First, concerns about acquisition strategy, concurrency, and funding profiles are not particularly dependent on time frames. Second, the DOD policy preference for incremental acquisitions used as criteria in comparing programs was in effect when both programs started. Third, the Global Hawk B, which comprises most of the Global Hawk program, did not begin production until after the start of Predator B. In a comparable time frame since then, the Predator B program has provided some interim combat capability and has production models flying and undergoing tests, while the first Global Hawk B is expected to make its first flight later this year.

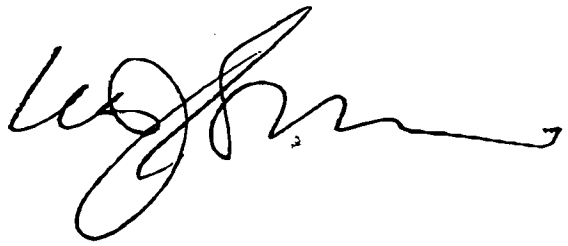
To identify what lessons can be learned and applied on the J-UCAS program, or its offspring, we interviewed DOD and contractor officials and obtained programmatic data and reports on J-UCAS. We used our comparisons of the Global Hawk and Predator, as well as past audit work on unmanned and manned systems, to identify factors conducive to successful programs and development of effective business cases and implementation strategies. We monitored the changes in J-UCAS leadership, priorities, and support within the department and Congress, including the most recent decisions by the Quadrennial Defense Review. We utilized also information obtained in past Quick Look and budget review efforts concerning J-UCAS.

In performing our work, we obtained information and interviewed officials from the Global Hawk, Predator, and Joint Unmanned Combat Air Systems Program Offices, all at Wright Patterson Air Force Base, Ohio; Air Combat Command, Langley Air Force Base, Virginia; Northrop Grumman Integrated Systems, Rancho Bernardo and Palmdale, California; General Atomics Aeronautical Systems, San Diego and Palmdale, California; and DOD Task Force for Unmanned Systems, Office of the Secretary of Defense, Washington, D.C.

We performed our review from August 2005 to February 2006 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Secretary of Defense, the Secretary of the Air Force, and the Secretary of the Navy, and interested congressional committees. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you have any questions regarding this report, please call me at (202) 512-4841. Contact points for our offices of Congressional Relations and Public Affairs are listed on the last page of this report. The following staff made key contributions to this report: Michael Hazard, Assistant Director, Bruce Fairbairn, Rae Ann Sapp, Charlie Shivers, Adam Vodraska, and Karen Sloan.



Michael J. Sullivan
Director, Acquisition and
Sourcing Management Issues

Appendix I: Unmanned Aircraft Systems Included in This Review

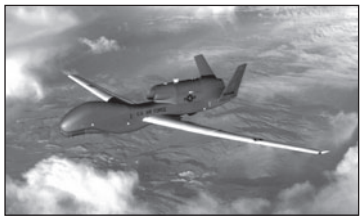
The Air Force's Global Hawk system is a high-altitude, long-endurance unmanned aircraft with integrated sensors and ground stations providing intelligence, surveillance, and reconnaissance capabilities. After a successful technology demonstration, the system entered development and limited production in March 2001. Considered a transformational system, the program was restructured twice in 2002 to acquire 7 air vehicles similar to the original demonstrators (the Global Hawk A) and 44 of a new, larger, and more capable model (the Global Hawk B). Seven Global Hawk As have been delivered to the Air Force. Global Hawk Bs are in production with first flight and first delivery expected in fiscal year 2007. Demonstrators have seen combat operations in Iraq and Afghanistan and the first Global Hawk As recently arrived in-theater.

The Predator began as a technology demonstration in 1994 and transitioned to an Air Force program in 1997. Predators have supported combat operations since 1995. Originally designed to provide tactical reconnaissance, the Predator A was modified in 2001 to employ Hellfire missiles, giving it a limited ground strike capability. In response to the Global War on Terror initiatives, the Air Force proposed a larger model carrying more weapons and flying higher and faster. The Predator B was approved as a new system development and demonstration program in February 2004. Funding plans at the time of our review were to procure a total of 232 Predators—181 A models and 63 B models—with additional future buys expected. Through calendar year 2005, 137 aircraft have been delivered, 8 Predator Bs and the rest Predator As.

The Joint Unmanned Combat Systems (J-UCAS) program is a joint Air Force and Navy effort begun in October 2003 to develop and demonstrate the technical feasibility and operational value of a networked system of high-performance, weaponized unmanned aircraft. Planned missions include suppression of enemy air defenses, precision strike, persistent surveillance, and potentially others such as electronic attack as resources and requirements dictate. The program consolidated two formerly separate service efforts and was to develop and demonstrate larger, more capable, and interoperable aircraft to inform decisions on starting acquisition program(s) in fiscal year 2012. The Quadrennial Defense Review calls for restructuring J-UCAS into a Navy effort to develop an unmanned carrier-based aircraft, while the Air Force will consider J-UCAS technologies and accomplishments in its efforts to develop a new, land-based long-range strike capability.

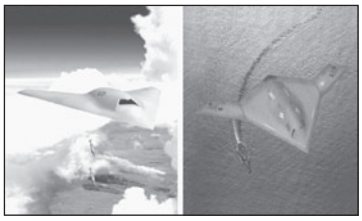
Figure 2 compares the salient performance characteristics of these unmanned aircraft systems.

Figure 2: Performance Characteristics of Unmanned Aircraft Systems Reviewed by GAO



Global Hawk

Predator



J-UCAS

	RQ-4A	RQ-4B	MQ-1A	MQ-9B	X-45C	X-47B
Maximum altitude	65,000 ft.	60,000 ft.	25,000 ft.	40,000 ft.	40,000 ft.	40,000 ft.
Maximum speed	350 knots	340 knots	118 knots	225 knots	460 knots	460 knots
Endurance	32 hrs.	28 hrs.	24 hrs.	16 hrs.	7 hrs.	9 hrs.
Payload capacity	1,950 lbs.	3,000 lbs.	450 lbs.	3,800 lbs.	4,500 lbs.	4,500 lbs.
Take-off weight	26,750 lbs.	32,250 lbs.	2,250 lbs.	10,500 lbs.	36,500 lbs.	46,000 lbs.
Wingspan	116 ft.	131 ft.	49 ft.	66 ft.	49 ft.	62 ft.
Fuselage length	44 ft.	48 ft.	27 ft.	36 ft.	39 ft.	38 ft.

Sources: Northrop Grumman Corporation; General Atomics-Aeronautical Systems, Incorporated; The Boeing Company; and DOD data.

Appendix II: Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION
TECHNOLOGY
AND LOGISTICS

MAR 1 [illegible]

Mr. Michael J. Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Sullivan:

This is the Department of Defense (DoD) response to the GAO draft report, "UNMANNED AIRCRAFT SYSTEMS: New DOD Programs Can Learn from Past Efforts to Craft Better and Less Risky Acquisition Strategies," dated February 10, 2006 (GAO Code 120462/GAO-06-447).

The DoD non-concurs with the draft report's first and second recommendation for the Global Hawk program, but concurs with the third, fourth, and fifth recommendation for the J-UCAS program. The rationale for the DoD's position is enclosed.

The Department appreciates the opportunity to comment on the draft report. For further questions concerning this report, please contact Dyke Weatherington, Deputy, Unmanned Aircraft Systems Planning Task Force, 703-695-6188.

Sincerely,

Mark D. Schaeffer
Acting Director
Defense Systems

Enclosure:
As stated

GAO DRAFT REPORT - DATED FEBRUARY 10, 2006
GAO CODE 120462/GAO-06-447

"UNMANNED AIRCRAFT SYSTEMS: NEW DOD PROGRAMS CAN LEARN FROM PAST EFFORTS TO CRAFT BETTER AND LESS RISKY ACQUISITION STRATEGIES"

DEPARTMENT OF DEFENSE COMMENTS TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Global Hawk program office to limit production of the Global Hawk B aircraft to the number needed for flight testing until the developer has demonstrated that signals intelligence and radar imagery subsystems can be integrated and perform as expected in the aircraft. (p. 21/GAO Draft Report)

DoD RESPONSE: Non-concur. The Department is managing risk in the Global Hawk program while continuing the acquisition approach that delivers increments of capability at the earliest opportunity. The first Global Hawk Block 20 aircraft will deliver and field with electro-optical, infrared, and synthetic aperture radar sensors similar to the Block 10 aircraft. When mature, signals intelligence capability will be fielded on the Block 30 aircraft. To reduce risk and concurrency to the Global Hawk program, signals intelligence capability will be integrated and flight tested first on the U-2 aircraft. Only when the capability is mature will it be transitioned to the Global Hawk. Similarly, the MP-RTIP radar for the Block 40 aircraft will first be flight tested on a surrogate platform to reduce risk and mature the capability. This strategy manages risk in each successive block and provides flexibly for integration of improved capability. The GAO recommendation would stop the current established production line, incurring significant cost and schedule delays. Combatant Commanders continue to request this capability, and the acquisition strategy balances risk with the need to support the warfighter. As part of the Department's Nunn-McCurdy process, the Department will consider all viable courses of action for the Global Hawk program that comply with the intent of Title 10 USC 2433 while preserving the capability.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense direct the Global Hawk program office to update business case elements to reflect the restructured program to include an analysis of alternatives, to justify investments in the specific quantities needed for each type of Global Hawk B's being procured (signals intelligence and advanced radar imagery), and a revised cost estimate. (page 21/GAO Draft Report)

DoD RESPONSE: Non-concur. The Department's current Nunn-McCurdy certification evaluation and program rebaselining is thorough, and tailored for the Global Hawk acquisition program, so as to provide Department leaders with the information to make informed decisions

which will fully comply with the requirements of Title 10 USC 2433. The department's analysis will determine if:

- The Global Hawk acquisition program is essential to the national security
- There are alternatives to the Global Hawk acquisition program, which will provide equal or greater military capability at less cost
- New estimates of the program acquisition unit cost or procurement unit cost are reasonable
- The management structure for the Global Hawk acquisition program is adequate to manage and control program acquisition unit cost or procurement unit cost

RECOMMENDATION 3: The GAO recommended that the Secretary of Defense direct the Navy and the Air Force organizations responsible for the development efforts stemming from the former J-UCAS program to not move into a weapon system acquisition program before determining requirements and balancing them to match proven technologies, a feasible design based on systems engineering by the developer, and available financial resources. (page 21/GAODraft Report)

DoD RESPONSE: Concur. The Department will follow Joint Capabilities Integration and Development System process to prepare requirements documentation to support a potential acquisition program. The capability gaps identified in the current Joint Strike Enabler Initial Capabilities Document form the basis of the J-UCAS program's requirements documents and are remain valid. As this process proceeds, various analysis and demonstrations will be completed that will balance requirements, resources, and technology maturity to develop a system concept that is at the appropriate technology readiness level for a Milestone B decision.

RECOMMENDATION 4: The GAO recommended that the Secretary of Defense direct the Navy and the Air Force organizations responsible for the development efforts stemming from the former J-UCAS program to not move into a weapon system acquisition program before developing an evolutionary and knowledge-based acquisition strategy that implements the intent of Defense acquisition policy. (page 21/GAO Draft Report)

DoD RESPONSE: Concur. The Department will follow the DoD 5000 series guidance to structure a potential acquisition program. Our approach has been, and remains one that is a knowledge-based, incremental approach that provides initial, incremental capability to meet the most immediate, achievable warfighting requirements while development of more complex capabilities continue. Our approach will also include clear entry and exit criteria for critical milestones to ensure that technologies are mature, and required incremental test objectives are achieved.

RECOMMENDATION 5: The GAO recommended that the Secretary of Defense direct the Navy and the Air Force organizations responsible for the development efforts stemming from the former J-UCAS program to not move into a weapon system acquisition program before establishing strong leadership empowered to carry out the strategy and that will work in

conjunction with the other services to ensure the design and development continue to incorporate commonality as initiated under the DARPA managed joint program. (Page 22/GAO Draft Report)

DoD RESPONSE: Concur. The Department's approach toward a potential acquisition program continues to emphasize empowered leadership, and to encourage commonality and interoperability throughout the Joint Forces to the maximum extent practical.

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Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes. GAO-06-110. Washington, D.C.: November 30, 2005.

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Defense Acquisitions: Assessments of Major Weapon Programs. GAO-05-301. Washington, D.C.: March 31, 2005.

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Unmanned Aerial Vehicles: DOD's Demonstration Approach Has Improved Project Outcomes. GAO/NSIAD-99-33. Washington, D.C.: August 16, 1999.

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