United States Government Accountability Office

GAO

Report to the Chairman, Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

November 2004

UNMANNED AERIAL VEHICLES

Changes in Global Hawk's Acquisition Strategy Are Needed to Reduce Program Risks

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Highlights

Highlights of GAO-05-6, a report to the Chairman, Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

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UNMANNED AERIAL VEHICLES

Changes in Global Hawk's Acquisition Strategy Are Needed to Reduce Program Risks

Why GAO Did This Study

Global Hawk offers significant military capabilities to capture and quickly transmit high-quality images of targets and terrain, day or night, and in adverse weather—without risk to an onboard pilot. Global Hawk first flew in the late 1990s as a demonstrator and supported recent combat operations in Afghanistan and Iraq. In 2001, the Air Force began an acquisition program to develop and produce improved Global Hawks. In 2002, the Department of Defense (DOD) restructured and accelerated the program to include a new, larger and more capable air vehicle. GAO was asked to review the program and discuss (1) the restructuring's effect on the Air Force's ability to deliver new capabilities to the warfighter and (2) whether its current business case and management approach is knowledge-based and can help forestall future risks.

What GAO Recommends

GAO recommends the Air Force revisit the decision to concurrently develop and produce the newer Global Hawk and create a new business case that defines warfighter needs and available resources. GAO also recommends that production be delayed (other than those units needed for testing) until the new business case is approved. DOD disagrees that these actions are needed because it believes risks are being managed effectively and GAO's approach would require more time and money to implement the program.

www.gao.gov/cgi-bin/getrpt?GAO-05-6.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Michael J. Sullivan at (202) 512-4163 or sullivanm@gao.gov.

What GAO Found

The restructuring of the Global Hawk program impacts the acquisition program in multiple ways.

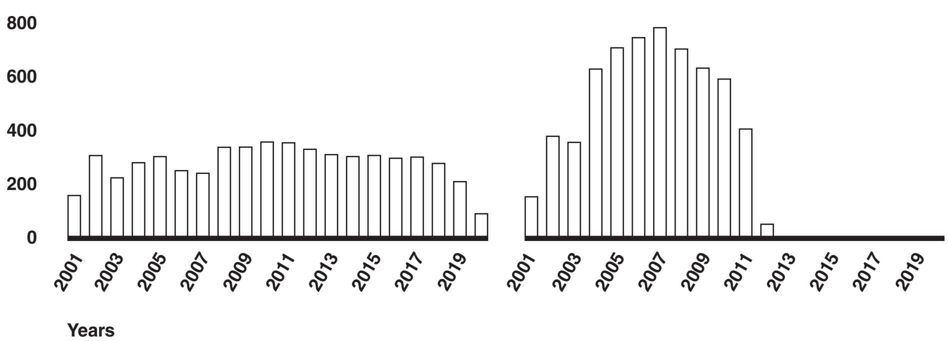
- **More and accelerated funding:** Funding, which previously spanned 20 years, now is compressed in about half the time. The restructured plan requires $6.3 billion through fiscal year 2012; the original plan would have needed $3.4 billion by that time. The budget request is now three times higher for some years (see figure below).
- **Immature technologies:** Several critical technologies needed to provide the advanced capabilities are immature and will not be tested on the new air vehicle until late in the program, after which most of the air vehicles will already have been bought.
- **New requirements, new costs:** DOD's desire to add additional Global Hawk capabilities tripled development costs. The program acquisition unit cost increased 44 percent since program start, yet fewer vehicles are to be produced than originally planned.
- **Challenges, trade-offs, and delays:** The addition of new capabilities has led to space, weight, and power constraints for the advanced Global Hawk model. These limitations may result in deferring some capabilities. Some key events and activities—many related to testing issues—have been delayed.

Global Hawk's highly concurrent development and production strategy is risky and runs counter in important ways to a knowledge-based approach and to DOD's acquisition guidance. The restructuring caused gaps in product knowledge, increasing the likelihood of unsuccessful cost, schedule, quality, and performance outcomes. Because the restructured program is dramatically different from the initial plan for the basic model, the business case now seems out of sync with the realities of the acquisition program.

Global Hawk's Annual Funding Requirements

Funding, as of September 2001, before restructuring (in millions of then-year dollars)

Funding, as of December 2003, after restructuring (in millions of then-year dollars)



Sources: Air Force (data); GAO (analysis).

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

November 5, 2004

The Honorable Curt Weldon
Chairman
Subcommittee on Tactical Air and Land Forces
Committee on Armed Services
House of Representatives

The Air Force's Global Hawk is a high-flying unmanned aerial vehicle that can capture detailed images of targets as well as wide swaths of terrain and transmit those images on a near real-time basis to battlefield commanders and intelligence centers. With an ability to see through clouds, sandstorms, and other inclement weather conditions day or night and to fly for more than a day, Global Hawk can significantly improve the Department of Defense's (DOD) ability to gather intelligence, surveillance, and reconnaissance[1] information about potential adversaries without risking an onboard pilot. An early model performed well in the ongoing global war on terrorism, and the Secretary of Defense identified Global Hawk as having the potential to transform military operations. The Air Force began the acquisition program in 2001. With total program cost estimated at $6.3 billion, Global Hawk is currently DOD's most expensive unmanned aerial vehicle. The Navy is considering Global Hawk for a maritime surveillance mission, and other federal agencies, several foreign countries, and the North Atlantic Treaty Organization have all expressed an interest in this aircraft system.

[1] Intelligence is defined by DOD as the product resulting from the collection, processing, integration, analysis, evaluation and interpretation of available information concerning foreign countries or areas. DOD also defines the term as information and knowledge about an adversary obtained through observation, investigation, analysis, or understanding. Surveillance is defined by DOD as the systematic observation of places, persons, or things through visual and other means. DOD defines reconnaissance as a mission undertaken to obtain, by visual observation or other detection methods, information about activities and resources of an enemy or potential enemy or to secure data characteristics of a particular area.

In 2002, DOD restructured the program, accelerating development and production, and, more importantly, changing the design significantly to a new, larger, heavier, and more capable air vehicle to handle both imagery and signals intelligence missions.[2] Given Global Hawk's overall importance to DOD, you asked us to review the program. This report discusses (1) the restructuring's effect on the Air Force's ability to deliver new capabilities to the warfighter in terms of funding, acquisition strategy, cost, and other related issues and (2) whether the current business case and management approach is knowledge-based and can help forestall future risks.

To determine the effects of restructuring on the Global Hawk program's cost, schedule, and performance goals, we reviewed the original acquisition strategy, two major restructurings, and the current acquisition strategy. We assessed changes to funding, annual budget requests, the number of vehicles to be procured, vehicle capabilities, and program cycles for developing, testing, and procuring Global Hawk. To evaluate the program's likelihood of meeting its objectives, we compared the current acquisition strategy with criteria established in DOD's acquisition policy[3] and with best practices and experiences of leading commercial firms and successful government acquisitions. This methodology, which we call a knowledge-based approach, enabled us to evaluate whether the program achieved product knowledge at the right times in terms of technology, design, and production maturity. We identified gaps in product knowledge, reasons for those gaps, and risks associated with inadequate knowledge. We performed our review from February 2004 to September 2004 in accordance with generally accepted government auditing standards. More details about our methodology are in appendix I.

[2] Imagery intelligence is defined by DOD as being derived from the exploitation of collection by visual photography, infrared sensors, lasers, electro-optics, and radar sensors (such as synthetic aperture radar sensors) wherein images of objects are reproduced optically or electronically on film, electronic, display devices, or other media. DOD defines signals intelligence as involving intelligence derived from communications, electronic, and foreign instrumentation signals.

[3] DOD Directive 5000.1 "The Defense Acquisition System" and DOD Instruction 5000.2 "The Operation of the Defense Acquisition System," both dated May 12, 2003.

Results in Brief

The Global Hawk program has changed dramatically since the March 2001 decision to start both system development and low-rate production. The program has been restructured twice to add the requirement for a totally new and larger Global Hawk design to be developed and produced in less time. Program funding, which previously had been stretched relatively evenly across 20 years, is now compressed into roughly half the time, tripling Global Hawk's budgetary requirements in some years. In fiscal year 2006, for example, the program now plans to request about $750 million from Congress, three times what was planned originally. The restructurings expanded the development period by 5 years and compressed production by 9 years, creating significant concurrency between development and production from fiscal year 2004 to 2010. Because of this concurrency, the Air Force plans to invest in almost half of the total fleet of the new larger Global Hawks before a production model is flight-tested and completed to show that the air vehicle design works as required. Likewise, full-rate production will begin before the airborne signals intelligence and multiplatform radar (the two required capabilities justifying the new, larger model) complete development and are flight-tested to prove the integrated system will work as intended. The primary reason for building the RQ-4B model was to integrate and carry the advanced sensors to provide added capability to the warfighter. The program's total cost estimates have increased by nearly $900 million, driven by a threefold increase in development costs to pay for the development of a new and larger air vehicle. As a result, the program acquisition unit cost increased 44 percent since the program started. Finally, in the past 2 years, the program has deferred some key capabilities and experienced delays that can impact getting capabilities to the warfighter.

The Air Force's restructured strategy does not fully follow the evolutionary, knowledge-based approach espoused by best practices and DOD's revised acquisition guidance. A knowledge-based approach encourages managers to attain the necessary product knowledge at key points to support investment decisions, ensuring, for example, that technologies are mature before starting an acquisition program and that the design is stable before beginning manufacturing. This approach includes incremental or evolutionary development, which sets up a more manageable environment for attaining and applying knowledge and is intended to increase the chances of delivering a quality weapon system to the warfighter quickly and cost effectively. While the original acquisition strategy more closely adhered to this approach, the restructured strategy has caused gaps in knowledge about technology, design, and manufacturing at major investment decision points. These actions changed the underpinnings of the program's original business case and increased the likelihood of future cost increases and schedule delays in delivering the capabilities expected by the warfighter. Air Force and contractor officials have established a wide range of management controls to help mitigate risks. While some of these controls may increase visibility into risks, the history of successful product development programs has shown that risk mitigation plans do not work optimally unless they are based on knowledge appropriate for decisions that must be made at critical junctures.

We are recommending that the Secretary of Defense direct the Air Force to revisit the decision to concurrently develop and produce the new Global Hawk design. The Secretary should direct the Air Force to conduct and present a new business case that defines the warfighter needs that can be accommodated given current available resources of technology, engineering capability, time, and money. To keep risks from increasing beyond current levels in this program, we also recommend the Secretary delay further procurement of the new Global Hawk, other than units needed for testing, until a new business case is completed that reduces risk and justifies further investments on a knowledge-based acquisition strategy. DOD disagreed with both recommendations, stating that risks are being effectively managed and that our approach would take more time and more money to implement. We continue to believe that our recommendations would improve congressional and DOD oversight, reduce program risks, and save time and money over the life of the program through a more rigorous and comprehensive application of knowledge-based practices.

Background

The Global Hawk unmanned aerial vehicle system is designed to support warfighting and peacekeeping missions by providing decision makers with up-to-date information about potential adversaries' locations, resources, and personnel. Operators on the ground can change Global Hawk's navigation and direct the onboard sensors to survey a geographic area the size of Illinois within a 24-hour cycle. As a high-altitude, long-endurance aircraft, Global Hawk was originally designed to reach an altitude of 65,000 feet and fly for up to 35 hours.

Global Hawk began in 1994 as an acquisition concept technology demonstration program, managed first by the Defense Advanced Research Projects Agency and, since 1998, by the Air Force. Seven demonstrator aircraft were eventually produced; three have since been destroyed in mishaps. The demonstrator models logged several thousand-flight hours and effectively supported combat operations in Afghanistan and Iraq. The system passed a military usefulness assessment, completed several demonstrations and other tests, and DOD judged it a success. However, testing identified that significant improvements in reliability, sensor performance, and communications were needed before producing operationally effective and suitable systems.

In March 2001, DOD approved the Global Hawk for a combined start of system development and low-rate initial production of six air vehicles based on the successful demonstrations and operational deployments of demonstrator aircraft. The Air Force planned to slowly develop more advanced capabilities and acquire 63 air vehicles. This model, now called the RQ-4A, is shown in figure 1.

Figure 1: Global Hawk RQ-4A

Source: Northrup Grumman.

In March 2002, DOD restructured the acquisition strategy to include a second Global Hawk model, the RQ-4B. The new strategy includes 51 air vehicles, 10 ground stations, multiple intelligence sensors, support equipment, and facilities at a cost of $6.3 billion. Of the 51 air vehicles to be purchased, 7 are RQ-4As and 44 are RQ-4Bs. Separately, the Navy is procuring 2 RQ-4As and a ground station for about $300 million (including development costs) to evaluate the vehicles' potential for the Broad Area Maritime Surveillance Program. In December 2002, DOD restructured the program again. Instead of buying all RQ-4Bs with multiple intelligence capability, the RQ-4Bs will now have a mix of multimission and single-mission capabilities. The two restructurings also increased low-rate initial production quantities to 19 (recently increased to 20) air vehicles: 7 RQ-4As and 12 (now 13) RQ-4Bs.

Differences between the Two Global Hawk Models

The RQ-4A and the RQ-4B differ significantly. The new RQ-4B model is intended to have 50 percent greater payload capacity, a longer fuselage and longer wing span and will be heavier than the A model. DOD considered these changes necessary to carry new advanced sensor payloads and to provide multi-intelligence capabilities on a single RQ-4B. Even though the RQ-4B is bigger and heavier, it will use the same engine as the RQ-4A. Table 1 shows the key differences in the two models.

Table 1: Key Characteristics of Global Hawk RQ-4A and RQ-4B Models

Key characteristics	RQ-4A	RQ-4B
Payload capacity	2,000 pounds	3,000 pounds
Take-off weight	26,750 pounds	32,250 pounds
Wingspan	116.2 feet	130.9 feet
Fuselage length	44.4 feet	47.6 feet
Endurance	31 hours	33 hours
Time at 60,000 feet	14 hours	4 hours
Average speed at 60,000 feet	340 knots	310 knots
Approximate range	10,000 nautical miles	10,000 nautical miles

Sources: Northrop Grumman (data); GAO (analysis).

In addition to the differences shown in table 1, the RQ-4B includes new requirements for advanced sensors payloads,[4] enhancements to communications and ground stations, a new multiplatform common data link, and an open systems architecture. The new design will use more advanced technologies (such as lithium batteries and electric brakes), will require a larger power-generating capability, and will incorporate new landing gears that fold into the wing. Also, the design changes require new manufacturing processes and investments in new production tooling—the factory equipment and manufacturing items used to build large quantities of major weapon systems, such as Global Hawk.

Restructured Global Hawk Program Attempts to Do More in Less Time

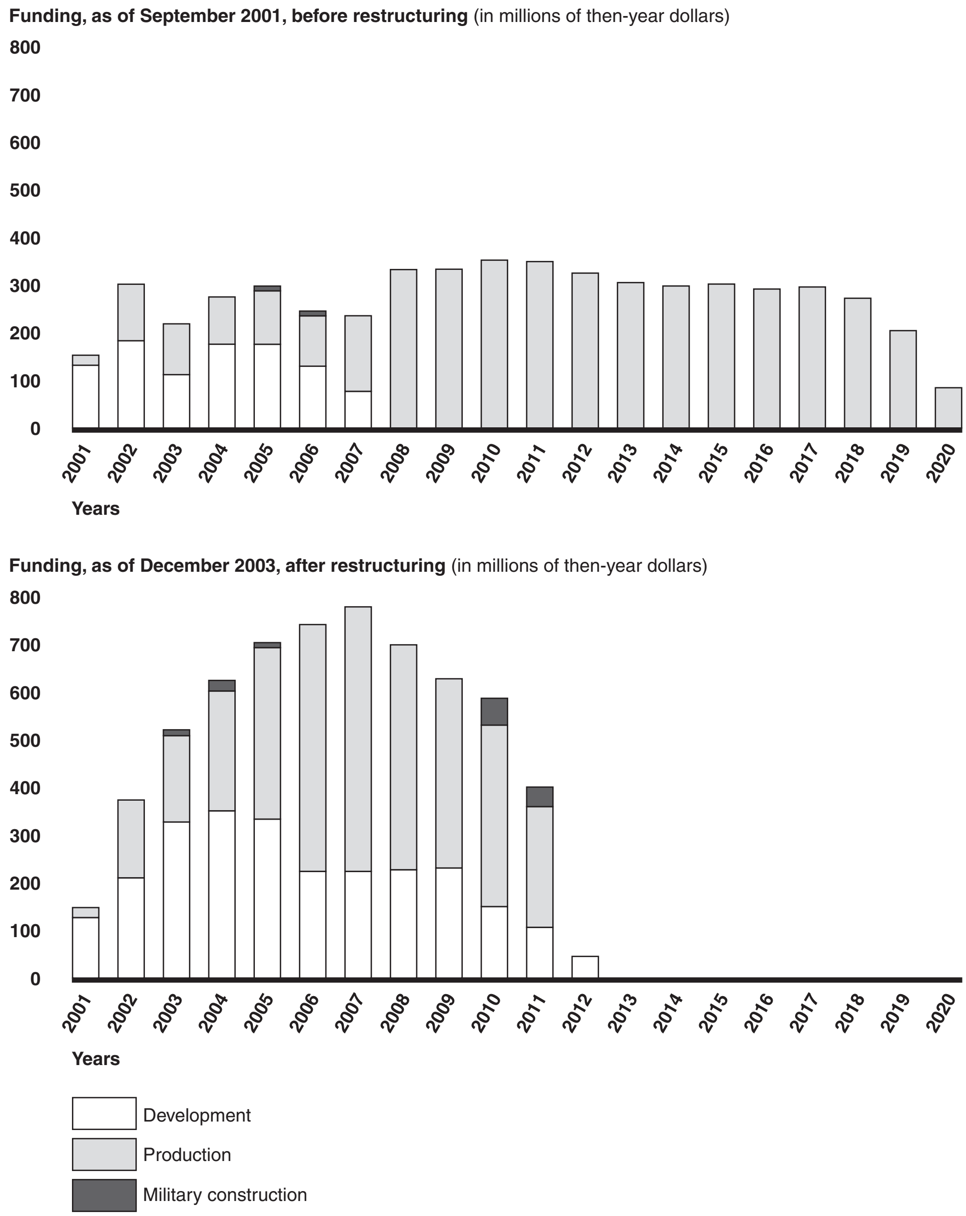
Global Hawk's restructuring has impacted the acquisition program in a number of significant ways: the time span for funding has been compressed into roughly half the time and the overall funding amount has increased; concurrent development and production is causing the Air Force to invest in almost half the total fleet of the new and improved Global Hawk vehicle before a production model has proven that it will work as intended; and development costs have tripled because of the need to develop a new and improved vehicle. In addition, the program has deferred some capabilities and incurred delays that could affect the Air Force's ability to deliver Global Hawk to the warfighter.

Annual Funding Needs Are Higher under Restructured Program

The restructured program requires greater up-front investment, a faster ramp-up in funding, and a larger total budget. The development period was extended from 7 years to 12 years, and development funding increased significantly to develop the RQ-4B and to integrate advanced sensor and communication technologies. Procurement is now concentrated into 11 years instead of the 20 years of relatively level procurement set out in the original plan. The restructuring triples Global Hawk's budgetary requirements in some years. Figure 2 illustrates the restructuring's compression of the program and impact on annual funding requirements.

[4] In addition to enhancements to existing imagery sensors, the RQ-4B will eventually incorporate the Airborne Signals Intelligence Payload and the MultiPlatform Radar Technology Insertion Program.

Figure 2: Global Hawk's Annual Funding Requirements



Sources: Air Force (data); GAO (analysis).

Compared with the original plan, the restructured plan has much higher annual funding requirements, placing more budgeted funds at risk of not being fully funded when competing for the defense dollar. In their respective peak years of budget requirements, the original plan would have required $353 million (fiscal year 2010), while the restructured plan expects to request $781 million (fiscal year 2007). The upcoming fiscal year 2006 requirement is currently about $750 million, three times higher than the original plan for that same fiscal year. Cumulatively, the restructured plan requires $6.3 billion to be completed in fiscal year 2012, whereas the original plan would only have needed $3.4 billion by that year.

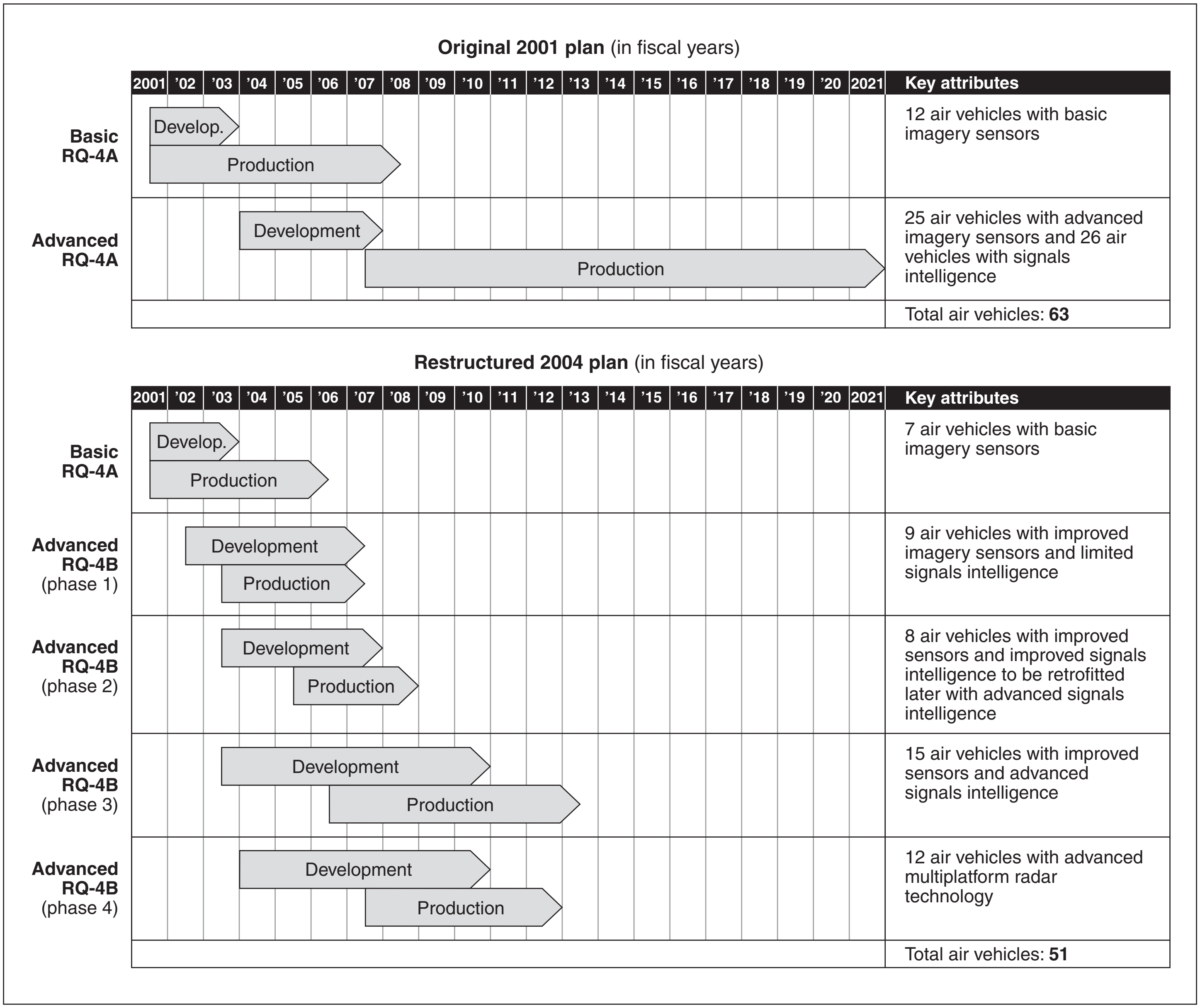
Restructured Program Increased Concurrency between Development and Production

Significant concurrency now exists between development and production that covers the period from fiscal years 2004 to 2010. The Air Force now plans to invest in almost half of the total RQ-4B fleet before a production model is flight-tested and operational evaluations are completed to show that the air vehicle design works as required. Full-rate production will begin before the airborne signals intelligence and multiplatform radar complete development and are flight-tested to prove the integrated system will work as intended. The primary reason for building the RQ-4B model was to integrate and carry the advanced sensors to provide added capability to the warfighter. Additionally, schedule delays have already occurred in the restructured plan that will continue to add pressure in the program.

Collectively, the actions to restructure the program have materially changed the underpinnings in the original business case decision developed to justify the start of system development and low-rate production. The business case should provide sufficient evidence that resources are available to meet warfighter needs. This case would include technology and design demonstrations that added confidence that the integrated product can be developed within time and money constraints. The original plan was to first acquire basic RQ-4A systems very similar to the demonstrators and then slowly and incrementally develop and acquire systems with more advanced sensor capabilities while using the same air vehicle. This strategy incorporated an evolutionary approach in that a basic capability was to be produced in a first block of aircraft and a second, more advanced block was to be acquired once the new technologies were mature. Each block had separate decision points and testing plans and significant risk was removed from the program because the demonstrators had been built, tested, and extensively flown (and later used successfully in actual combat operations in Afghanistan and Iraq). While testing showed it needed some improvements, the RQ-4A was significantly more mature and proven than the RQ-4B model to begin production.

Figure 3 illustrates the significantly greater concurrency of development and production activities resulting from the program's restructuring compared with the original plan. Historically, programs with high degrees of concurrency are at greater risk of cost, schedule, and performance problems than programs with less overlap of development and production. The original acquisition strategy planned to complete most development testing prior to beginning production, thereby taking advantage of product knowledge. The restructured program added the new RQ-4B model, substantially increased low-rate production quantities, and established highly concurrent development and production cycles to acquire and test several different RQ-4B configurations over the life of the program. The Air Force plans to invest in 20 RQ-4Bs before completion of initial operational test and evaluation. The reason for designing a larger and heavier Global Hawk was to satisfy warfighter needs for the new advanced sensors. However, integration and operational testing of the advanced sensors on the fully configured air vehicle are not scheduled to be completed and reported on until fiscal year 2009 for the advanced signal intelligence sensor and fiscal year 2011 for the multiplatform radar. By this time, the entire RQ-4B fleet will already be produced or on order.

Figure 3: Restructured 2004 Plan Is Highly Concurrent Compared with Original Global Hawk Plan



Sources: Air Force (data); GAO (analysis).

Note: In this figure, development includes both technology and system development.

Restructured Program Added Requirements and Increased Costs

Global Hawk's development cost estimates have increased almost threefold, from $906.2 million in March 2001 to about $2.6 billion in March 2004, mostly due to the requirement for the new RQ-4B's inclusion in the program. Total program costs have continued to increase, including an increase of $466 million since March 2003. The program acquisition unit cost increased 44 percent since program start, from $85.6 million to $123.2 million. Increasing costs for Global Hawk raises affordability issues and questions about employing the vehicle in medium- and high-threat environments because of its high replacement costs and limited numbers. Total procurement cost estimates decreased from program start due to the cut in quantities from 63 to 51 and inflation savings resulting from compressing the program and cutting 9 years of future procurement activities. Table 2 shows how costs have changed since March 2001 in millions of then-year dollars.

Table 2: Global Hawk Program's Cost, Quantity, and Unit Costs

	March 2001 (original plan)	March 2002 (1st restructuring)	March 2003 (2nd restructuring)	March 2004 (status this year)
Total cost[a]				
Development	$906.2	$2,311.0	$2,395.6	$2,587.9
Procurement	4,459.8	4,388.9	3,278.5	3,552.2
Military construction	28.0	146.7	140.8	140.8
Total program	**$5,394.0**	**$6,846.6**	**$5,814.9**	**$6,280.9**
Quantity				
Air vehicles	63	51	51	51
Ground stations	14	10	10	10
Unit costs[a,b]				
Total program	**$85.6**	**$134.2**	**$114.0**	**$123.2**
Procurement only	$70.8	$86.0	$64.2	$69.6

Sources: Air Force (data); GAO (analysis).

[a]All costs are expressed in millions of then-year dollars, which include inflation and represent the Air Force's budget plans.

[b]Total program unit cost is calculated by dividing the total cost of development, procurement, and system-specific military construction for the acquisition program by the quantity of air vehicles to be produced. Procurement unit cost is the total amount for procurement divided by the number of air vehicles to be procured. It does not include costs for development and military construction.

The following factors caused the Global Hawk program's cost estimates to change between 2001 and 2004:

- **March 2001 cost estimate:** Based on the original acquisition strategy to slowly and incrementally develop and acquire improved versions of the demonstrator model. The RQ-4B model was not yet part of the acquisition strategy.

- **March 2002 cost estimate:** Reflects changes for the first restructuring of the program, which introduced the RQ-4B. Development costs increased significantly because of plans to quickly build advanced capabilities into the RQ-4B. While the quantity of air vehicles—the RQ-4A and RQ-4B models—and ground stations decreased because of revised user requirements, total procurement costs increased because of the higher cost for the RQ-4Bs and the plan at that time to equip all the larger platforms with multi-intelligence mission capabilities.

- **March 2003 cost estimate:** Reflects a second restructuring for affordability reasons. In December 2002, DOD officials decided to switch from all multimission capabilities to a mix of multimission and single-mission RQ-4Bs. This switch lowered procurement costs by decreasing the required number of sensors.

- **March 2004 cost estimate:** Between March 2003 and March 2004, total program cost increased by $466 million, and officials added another 18 months to the development program to accomplish requirements deferred from prior years and to accommodate new requirements. Development costs increased to cover the extended schedule and additional requirements. Procurement costs increased primarily because of higher costs for structural components and for labor to build the RQ-4B.

Restructured Program Has Created Other New Challenges

Space, weight, and power constraints of the RQ-4B limit what capabilities can be included now or added in the future. Some capabilities have already been eliminated or deferred to later years. For example, the warfighter wanted a defensive subsystem for Global Hawk, but development has been delayed and may be dropped because of weight limitations in the air vehicle, already at or near capacity with some of the new advanced sensor payloads. Also, the RQ-4B configured with the airborne signals intelligence payload is projected to have no capacity for future growth because this payload weighs more than allocated in the design of the air vehicle.

Other development tasks have similarly been delayed or pushed out beyond the budget years, including efforts related to demonstrating that Global Hawk can operate in areas with extreme temperatures.

The Air Force's overall acquisition approach to add new technologies whenever they are deemed ready was designed to allow flexibility in responding to changes in priorities and new requirements. However, Global Hawk's vehicle limitations and changing requirements have increased development challenges. For example, despite the space, weight, and power limitations of the RQ-4B, Air Force officials stated that Global Hawk users and other DOD officials continue to identify potential future technologies and capabilities for possible incorporation into Global Hawk. Absent major downsizing of the advanced sensors or other payloads, the Air Force will need to consider dedicating the RQ-4B to an increasing number of single and specific—rather than multi-intelligence—missions, if the goal is to utilize new and unproven emerging technologies not currently part of the Global Hawk plan.

Delays in Key Events Since Restructuring Can Impact Delivery of New Capability

The new schedule for some key events and activities has slipped because of programmatic, budget, or external issues. Air Force and contractor officials say that a significant contributor to schedule delays was the episodic deployment of Global Hawk's earlier model in Afghanistan and Iraq. The Global Hawk system—including considerable numbers of Air Force and contractor personnel, ground stations, and supporting equipment—has been used to support combat operations and is subject to future deployment orders.

Some examples of program events that have been delayed and others whose future schedules have slipped include:

- government acceptance of the second RQ-4A production aircraft due to quality and performance problems identified during tests;
- delivery of the equipment and support needed to begin initial operations at the Global Hawk's home base, Beale Air Force Base in California;
- the operational assessment of the RQ-4A;
- completion of the first phase of combined developmental and operational testing of Global Hawk;

- acquisition of production tooling, establishing manufacturing processes, and delivering parts needed for production;
- delivery schedules projected for RQ-4B air vehicles; and
- the expected start of initial operational test and evaluation to support the full-rate production decision.

Delays and deficiencies in scheduled development testing could compromise upcoming decisions in the program. According to test officials in the Office of the Secretary of Defense, the first of five phases of Global Hawk's combined development and operational testing is not as robust as originally planned and is taking significantly longer than expected. As of July 2004, only about 10 percent of the required flight test points had been completed and nearly 70 percent of the remaining test points were either on hold or not fully defined. The approved test plan required this testing to be completed by September 2004, but testing officials do not expect it to be completed until March 2005. Test delays are occurring due to late delivery of key subsystems, lack of resources, deployments in support of the global war on terrorism, other program priorities, and unexpected testing problems. Test officials told us that the lack of quality test data is hampering their ability to provide meaningful oversight.

The results from this first phase of development testing were to be used in the operational assessment of the first two production RQ-4A aircraft starting in September 2004 to assess the Global Hawk's mission readiness and suitability. Because of phase one delays, the start of the assessment has slipped until at least March 2005. Test officials believe further delays are likely because of other higher priorities, including the start-up activities at Beale Air Force Base. At this time, a firm date for the testing has not been scheduled and the unapproved test plan still lacks the necessary details to ensure effective testing. Test officials believe the operational assessment is in jeopardy of being cancelled or cut back in order to start the dedicated initial operational test and evaluation on time. The officials say that eliminating the operational assessment, or reducing its scope, would add risk to the program. Entering the next phase involves testing the new, larger RQ-4B aircraft and advanced sensor payloads, and, without having the assurances the production aircraft are mission-ready, additional tests will likely be required.

Global Hawk Program's Current Management Approach Sets Stage for Additional Risks

In attempting to get advanced capabilities to the warfighter sooner, the Air Force's restructured acquisition strategy for the Global Hawk program does not fully follow best practices and DOD acquisition guidance for an evolutionary, knowledge-based acquisition process. DOD recently rewrote its acquisition policy specifically to encourage acquisitions to develop and deliver increased capability to the warfighter incrementally (or on an evolutionary basis), only when appropriate knowledge concerning technology, design, and manufacturing has been attained. Compared with the original strategy, the new Global Hawk acquisition strategy has yielded less product knowledge in each of these areas, thereby raising the likelihood of future negative impacts on cost, schedule, and performance. Air Force and contractor officials acknowledge that—with its highly compressed and concurrent schedule—the program is risky and presents major management challenges. The Air Force has established management controls and processes intended to mitigate risks; however, without a disciplined process to capture and base investment decisions on key technology, design, and manufacturing knowledge, the controls are less robust and the risks remain high.

Restructured Acquisition Strategy Does Not Fully Capture Product Knowledge at Key Decision Points

By approving the start of system development and low-rate production at the same time, Global Hawk's restructured acquisition strategy skipped the critical decision points that require the capture of key product knowledge used to inform decisions to move forward in an acquisition program. Skipping the necessary steps to capture technology, design, and manufacturing knowledge has added risk to the program. The Air Force would have captured more knowledge under the original March 2001 strategy, which more closely followed the knowledge-based approach. At that time, the plan was to acquire basic air vehicles and ground systems very similar to the demonstrators that had already been built, extensively flown, and (later) used in combat. The Air Force then planned to upgrade sensor and performance capabilities for the next production lot as the technologies matured while retaining the same airframe. Since the decision to start the program, additional information and experience have closed some of the gaps, but a substantial lack of knowledge continues to add risk to the RQ-4B acquisition.

GAO has a body of work focused on best practices in product development and weapon systems acquisition.[5] We have found that when program managers capture key product knowledge at three critical knowledge points during a major acquisition, the probability of meeting expected performance within cost and schedule objectives increases. Each of the points builds on previously attained knowledge. The acquired knowledge is used to identify and reduce any risks before moving a weapon system to the next stage of development. This approach to developing new products—commercial and defense—has been shown over time to continually produce successful outcomes in terms of cost, schedule, and performance.

In recent years, DOD revised its acquisition policy to embrace an evolutionary and knowledge-based approach, which we believe provides a sound framework for the acquisition of major weapon systems. This policy covers most of DOD's major acquisition programs. As noted in our November 2003 report,[6] this revised policy is a step in the right direction. The acquisition policy states that program managers shall provide knowledge about the key aspects of the system at key decision points in the acquisition process[7] and an evolutionary or incremental development approach should be used to establish a more manageable environment for attaining and applying knowledge. The customer may not get the ultimate capability right away, but the initial product is available sooner and at a lower cost. The policy adopts the essence of the following points from the knowledge-based approach:

- **Knowledge point 1:** Should occur when the acquisition program is scheduled to start, when the customer's requirements are clearly defined, and resources—proven technology, engineering capability,

[5] GAO, *Defense Acquisitions: Assessments of Major Weapon Programs*, GAO-04-248 (Washington, D.C.: Mar. 31, 2004). This report includes an assessment of the Global Hawk program against the knowledge-based approach. Other recent reports discussing best practices include GAO, *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002) and *Defense Acquisitions: DOD Faces Challenges in Implementing Best Practices*, GAO-02-469T (Washington, D.C.: Feb. 27, 2002).

[6] GAO, *Defense Acquisitions: DOD's Revised Policy Emphasizes Best Practices, but More Controls Are Needed*, GAO-04-53 (Washington, D.C.: Nov. 10, 2003).

[7] For example, the policy states that unless some other factor is overriding in its impact, the maturity of the technology shall determine the path to be followed by the program in entering the system development phase of the acquisition cycle.

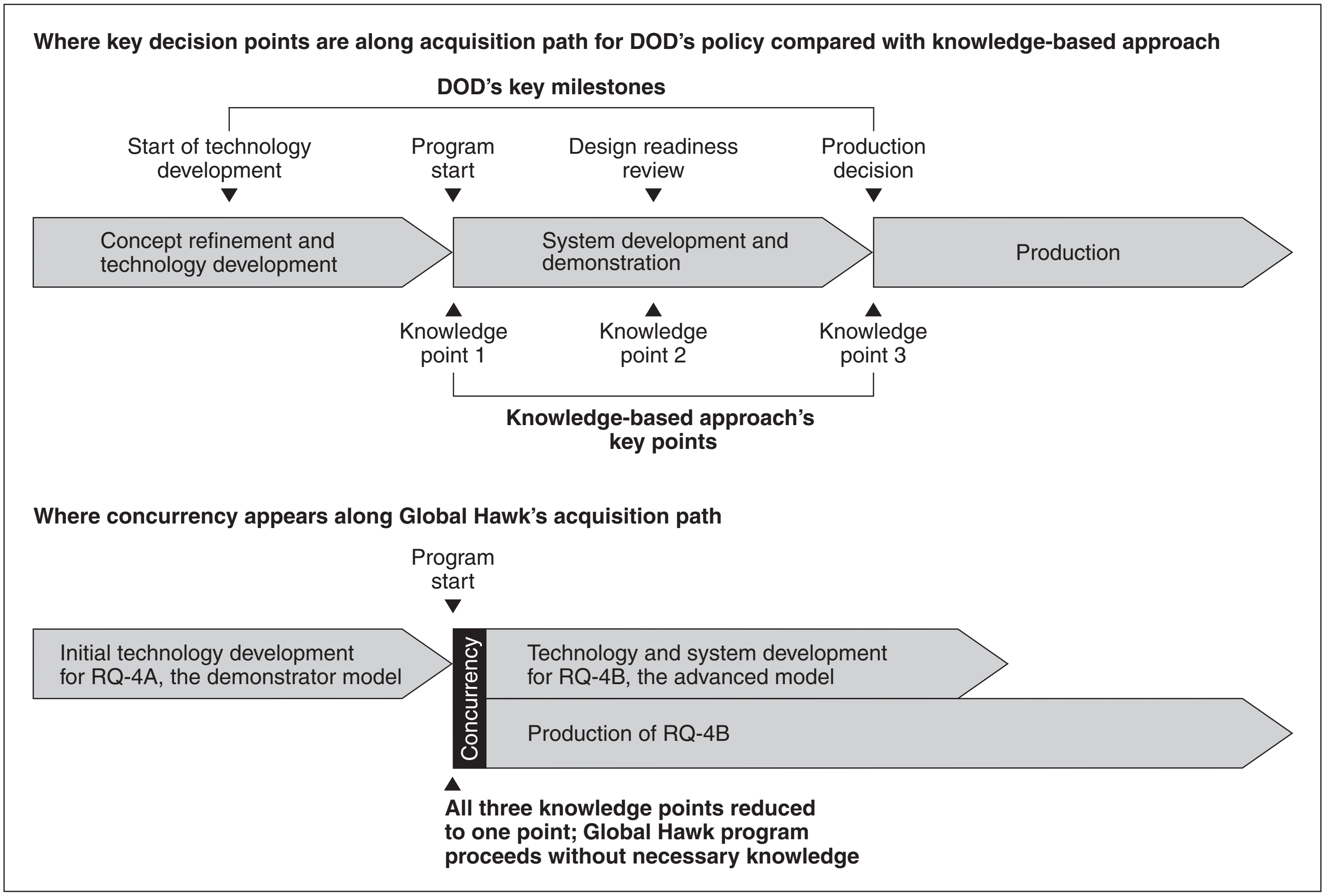
time, and money—exist to satisfy them. This match should support the business case for starting system development and demonstration. Technology should be mature before starting a program, and, therefore, the technology development phase of an acquisition should be separate from the system development phase.

- **Knowledge point 2:** Should occur at the design readiness review, about halfway through the system development phase, when the product's design is determined to be capable of meeting product requirements—the design is stable and ready to begin initial manufacturing of prototypes.

- **Knowledge point 3:** Should occur when managers commit to starting production, when information is available to determine that a reliable product can be produced repeatedly within established cost, schedule, and manufacturing quality targets.

Figure 4 shows a generalized depiction of DOD's acquisition policy, where DOD's key milestones are anchored along a typical program's acquisition path and where the three knowledge points from the knowledge-based approach fit along this path. Also shown in figure 4 is how the Global Hawk program overlaps technology and system development and begins production before the necessary knowledge is achieved.

Figure 4: Global Hawk Program Is Not Fully Aligned with DOD's Acquisition Policy and Knowledge-Based Approach



Sources: DOD and Air Force (data); GAO (analysis).

Global Hawk's new strategy approved initial production of the improved RQ-4B well in advance of completing technology maturation and approved developing and integrating the vehicle's design with the various sensor payloads desired by the warfighter. Furthermore, low-rate production was approved without ensuring the quality and reliability of manufacturing processes. This approach added significant risk in that sensor technologies and final design may not meet the space, weight, and power limitations of the RQ-4B, which is in low-rate production, and may not satisfy the warfighter's requirements. By not closing knowledge gaps in the integrated product design (air vehicle, sensor payloads, and data links) needed to meet requirements, there is increased risk that sensor development schedules may need to be extended to achieve form, fit, and function for an integrated Global Hawk system. Otherwise, the program office may have to go back to the warfighter and further negotiate requirements. Table 3 compares the product knowledge available to support key decision points under the original plan in March 2001 with the knowledge obtained at the start of RQ-4B production in July 2004. A black dot indicates product knowledge meets best practice standards from knowledge-based approach.

Table 3: How Global Hawk Product Knowledge Compares with Three Critical Points in the Knowledge-Based Approach

Global Hawk program status:		
Date	**March 2001**	**July 2004**
Status	At combined system development and limited production decision for RQ-4A	At start of RQ-4B production for basic RQ-4B air vehicle design with limited signals intelligence
Three critical points of knowledge-based approach and best practice standards:		
Knowledge point 1: Technologies needed to meet essential product requirements have been demonstrated to work in their intended environment, and the producer has completed a preliminary design of the product.		
Technologies matured to high readiness levels	•	
Preliminary design established	•	•
Knowledge point 2: Design is stable and has been demonstrated through prototype testing. Ninety percent of engineering drawings releasable to manufacturing organizations.		
90 percent of engineering drawings released	•	[a]
Prototype demonstration that design should meet requirements	•	[b]
Reliability targets and growth curve established		
Knowledge point 3: Product is ready to be manufactured within cost, schedule, and quality targets. All key manufacturing processes have come under statistical process control and product reliability has been demonstrated.		
Fully integrated system representative prototype demonstrated to work in operational environment	•	
Critical processes capable and in statistical control		
Reliability demonstrated		

Sources: Air Force (data); GAO (analysis).

Note: A black dot (•) indicates product knowledge meets best practice standards from knowledge-based approach.

[a]75 percent of drawings released at design readiness review in April 2004.

[b]System representative prototype will not be built. Since the basic design evolved from RQ-4A, the Air Force and contractor are conducting modeling efforts and component tests, such as wind tunnel testing of the new wing, to validate that the RQ-4B air vehicle design should meet requirements.

The table shows that the level of product knowledge approached best practice standards when the decision was made in March 2001 to start system development and low-rate production of the RQ-4A. The program's restructurings in 2002, however, created substantial gaps in technology, design, and manufacturing knowledge that have not yet been closed by the start of RQ-4B production. Lack of product knowledge increases risks of poor cost, schedule, and performance outcomes. Appendix III includes a more detailed discussion of knowledge gaps at each knowledge point. Following are brief examples of knowledge gaps as they relate to each of the three critical knowledge points.

Technology maturity: Using best practices, at the start of system development, a program's critical technologies should be in the form, fit, and function needed for the intended product and should be demonstrated in a realistic environment. The RQ-4B development program is struggling to meet these criteria for several of its most critical technologies. Nearly 2 years after development began, the technologies required for the RQ-4B to perform its operational mission including enhanced imaging sensors, signals intelligence, multiplatform radar, and open system architecture are immature, basically at a functional rather than form or fit configuration. For example, the airborne signals intelligence payload and multiplatform radar technology insertion program are still in development under separate Air Force programs. These subsystems are key to providing the advanced intelligence, surveillance, and reconnaissance capabilities for which the RQ-4B is being developed. At the time of our review, neither of these technologies had been demonstrated in an operational environment using a system prototype. Air Force officials expect them to be mature by the time they begin buying sensors to incorporate them into the Global Hawk production line in fiscal years 2008 and 2009. However, by this time most of the air vehicles will have already been bought. Also, operational testing to evaluate performance in a realistic operating environment is not scheduled until late fiscal year 2008 for the signals intelligence sensor and late 2010 for the radar. Nevertheless, the Air Force continues to build the RQ-4B platform lacking solid assurance that these critical subsystems will work as planned.

Design maturity: The program had completed 75 percent of RQ-4B model drawings by the design readiness review in comparison with the 90 percent completion standard for best practices. While the Air Force anticipated the design and experience on the RQ-4A would add assurances and speed efforts to mature the new RQ-4B design, the two vehicles ultimately had only about 10 percent commonality. While drawings completed were approaching best practice standards, the Air Force did not build a prototype of the RQ-4B design to demonstrate a stable design. Demonstration of the design is a key factor in ensuring a stable design. The Air Force had not established a reliability growth goal or plan and had not identified critical manufacturing processes, both essential to the next phase of production and needed to ensure quality and cost targets can be met.

Production maturity: Officials have started to identify the critical manufacturing processes for the RQ-4B but do not intend to collect and use statistical process control data to ensure the manufacturing could deliver quality products. The new RQ-4B requires new manufacturing processes because of major differences from the RQ-4A. In addition, Officials from the program office, the prime contractor, and the Defense Contract Management Agency continue to identify problems and concerns about the performance and quality of work by several key subcontractors, including those producing the wing, the advanced sensor suite, and the vertical tail and aft fuselage parts. This latter subcontractor is new to large-scale manufacturing using advanced composite materials and has experienced significant start-up and quality problems. According to best practices, the subcontractor's critical processes must be demonstrated to ensure good quality and limit rework. The prime contractor and DOD sent special teams of advisors to help develop the firm's manufacturing processes and to train employees. Creating another gap in production maturity, a fully integrated system representative prototype was not tested before starting production and will not have been demonstrated before full-rate production, scheduled in 2007. By then, 45 percent of the RQ-4B planned quantities will be under contract.

Joint Efforts Will Help Manage Risk in the Global Hawk Program

Air Force and contractor officials agree that the restructured program significantly increased program and technical risks. They acknowledge that the use of the approach to insert technology periodically affects all aspects of the program, making it more challenging to manage functional areas, including logistics support, contracting, program integration, and testing. To better manage the risks and challenges created by this acquisition approach and environment, the Global Hawk management team provided the following as examples of actions they are taking

- better teaming practices between the government and contractor to manage the program at all levels;

- better controls for the release of funds on both development and production contracts;
- allocation of higher amounts of management reserve funding during contract performance;
- use of a "buy to budget" concept that limits activity in the program to a ceiling amount of funds planned for the total program; and
- use of a risk management database to focus the attention of management on the most critical risks facing the program.

These are all management practices that can be used to manage any product development program and will likely identify and help manage risks in the Global Hawk program. Nevertheless, using a knowledge-based approach that captures critical knowledge at key junctures in a program has been shown time and again in both commercial and defense acquisition programs to consistently produce successful outcomes—cost, schedule, quality, and performance.

Conclusions

In March 2001, DOD approved the start of development and production for Global Hawk on the basis of a business case that matched requirements with resources—technologies, engineering capabilities, time, and funding. The first increment of Global Hawk was based on mature technologies and a design proven to meet the warfighter's need through actual combat use of the technology demonstrator. The plan included a reasonable funding profile and embraced a knowledge-based acquisition strategy that completed development before entering production. The plan included future improvements to the baseline capability as technologies and funding became available. By December 2002, the Air Force had dramatically changed the Global Hawk's acquisition plan and the knowledge-based foundation for the earlier decision to proceed into development and production. This change created large gaps between Global Hawk's requirements and the resources available to meet them. The new plan required a new, larger, and heavier air vehicle with only 10 percent commonality with the previous proven design; increased development time; and accelerated production time, creating significant concurrency between development and production. To accommodate the changes, the plan calls for twice the annual funding amounts in peak years over the old plan. Overall, the new plan has increased risks significantly. Subsequent reviews by DOD have acknowledged the changes in the program have increased uncertainty. The new design has not been demonstrated to work using a prototype model; technologies to support the advanced sensor payloads that drove the need for a new Global Hawk design are still immature; and the Air Force will be requesting about $750 million in funding next year for the program. Yet, the Air Force has awarded a contract to start the production of the new, larger Global Hawk B model with the hope that simulations and analysis will be sufficient to allow decision makers to manage risk. The history of DOD managed programs suggests otherwise.

Recommendations for Executive Action

To decrease risks of poor outcomes and to increase the chances of delivering required warfighter capabilities with the funds available, we are making recommendations to the Secretary of Defense to take the following two actions

- direct the Air Force to revisit the decision to begin concurrent development and production of the Global Hawk B design and direct the Air Force to create and present a new business case that defines the warfighter's needs that can be accommodated given current available resources of technology, engineering capability, time, and money, and

- delay further procurement of the Global Hawk B, other than units needed for testing, until a new business case is completed that reduces risk and justifies further investments based on a knowledge-based acquisition strategy.

Agency Comments and Our Evaluation

DOD provided us with written comments on a draft of this report. The comments appear in appendix II. DOD stated that it did not concur with our two recommendations. Separately, DOD provided one technical comment that we incorporated in this report to more accurately characterize the issue of affordability and use of Global Hawks in threat conditions.

Regarding our first recommendation on completing a new business case to justify and guide concurrent development and production of the RQ-4B model, DOD stated its belief that the Global Hawk's acquisition strategy balances acquisition risks with the department's demands to rapidly field new capabilities to the warfighter, thereby obviating the need for a new business case. Furthermore, by following what officials call an evolutionary development process, DOD said it is providing transformational warfighting capabilities to ongoing military operations without disrupting Global Hawk's current development and production activities. DOD said it is effectively managing risk with the help of regular oversight meetings and by requiring monthly and quarterly activity reports.

We continue to believe that a new business case is needed to support further investments and to improve oversight by Congress and DOD decision makers. The program today is much different than the one supported by the original business case. The Air Force started with an advanced concept technology demonstration program that proved the capability of a smaller and lighter Global Hawk air vehicle. Use of this vehicle on numerous occasions in actual combat situations has saved lives, according to Air Force and contractor officials. However, this is not the vehicle that the Air Force now plans to produce. Instead, the Air Force dramatically changed the acquisition strategy for the Global Hawk program and is not gaining some key knowledge before production. The Air Force plans to concurrently design and produce a new Global Hawk air vehicle that is significantly larger and heavier than the earlier version used in combat. The larger air vehicle is intended to accommodate new, heavier, and larger sensors that will not be available until the 2008 to 2009 time frame. In implementing the restructured strategy, the Air Force is not fully following a knowledge-based approach for developing the RQ-4B Global Hawk as called for by best practices and DOD's new defense acquisition guidance. The new guidance clearly states that knowledge reduces risks, and we agree.

While the Air Force believes it can manage the risk of a concurrent development and production program by holding regular meetings with acquisition executives and by issuing management reports, DOD's own experience has shown this to be risky and a factor that led DOD to change its acquisition policy to a knowledge-based approach. History has shown concurrency usually delays the delivery of a needed capability and results in higher costs. From March 2003 to March 2004, estimated program costs have increased by $466 million, and the sensors and the new air vehicle are still being developed. Stepping back from this rush to produce the new air vehicle and establishing a new business case designed to capture key product knowledge before costly investments in production would better inform DOD decision makers and Congress about what is feasible with available technology and dollar resources to meet warfighter needs and to better assess the extent and/or severity of program acquisition risks.

Regarding our second recommendation to delay further procurement of the RQ-4B (other than units needed for testing) until a new knowledge-based and risk-reducing business case is prepared, DOD stated that its current acquisition strategy effectively manages risk and fosters the rapid delivery of needed capabilities to the warfighter. DOD said we overstated risks from RQ-4B development, design changes, and insertion of advanced sensor capabilities. DOD further stated that our recommendation would result in a production break with serious cost and schedule complications and that GAO's sequential knowledge-based approach does not consider real-world events, such as the September 11, 2001, terrorist attack in the United States or issues related to North Korea and Iraq.

We believe the risks in the Global Hawk program are real and continue to support delaying the near-term procurement of air vehicles not needed for testing. We think this is a prudent way for the program to gain knowledge before significantly increased resource investments and to reduce risks until a new air vehicle integrated with the advanced signals intelligence payload and the multiplatform radar can be demonstrated through testing to meet warfighter requirements. Our report notes that operational testing of the air vehicle's performance and suitability will not take place until almost half the fleet is already purchased and that integration and testing of the advanced sensors will not occur until late in the program after the full-rate production decision is made and most systems are bought. DOD's comments appear to decouple the air vehicle from the advanced sensors by stating that, if a sensor diverges from its current plan, alternate future payloads could fill the RQ-4B's greater payload capacity. However, the need for designing a new larger air vehicle was predicated on its ability to carry these specific sensors to meet the warfighter's requirements. Therefore, we believe that knowledge based on a demonstration of the integrated capability is key to supporting production and delivery of the product within estimated cost and schedule. Additionally, the new Global Hawk program strategy requires significantly greater amounts of funding earlier, putting that investment at risk should changes occur as development and testing is completed.

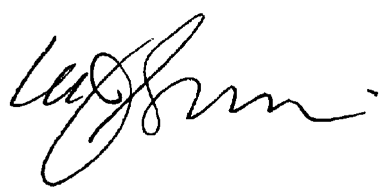
Regarding a potential break in production, our analysis indicates that a break is neither impending nor certain if our recommendation were adopted. We are not recommending that DOD stop production or reduce the total quantity but rather a near-term delay in procuring the portion of annual buys for air vehicles not needed for testing. Funds currently on contract and approved appropriations for fiscal year 2005 would continue production on the Air Force's planned schedule through mid-fiscal year 2007 at least. Only then would a production break or slowdown happen, and only if the Air Force has not yet prepared a business case to justify its investments beyond that point based on demonstrated product knowledge of the new air vehicle. If the current acquisition strategy and financial plan are feasible and appropriate, the Air Force would be able to prepare and justify a comprehensive business plan for the RQ-4B well in advance of a potential break.

DOD indicated that our knowledge-based acquisition approach was untimely and not adaptive to fast-changing world events. When we developed the knowledge-based approach, our high priority was to focus on better ways to deliver capability to the warfighter more quickly through incremental, or evolutionary, development. Our approach is based on a careful study of historical DOD acquisition programs and the best efforts in the private sector. Our prior work shows that proceeding without requisite knowledge ultimately costs programs more money and takes longer to complete than those adopting a more rigorous and comprehensive strategy basing investment decisions on key product knowledge—technology, design, and production maturity levels. DOD agreed with our findings and changed its acquisition guidance to reflect a knowledge-based approach. We note in this report that the original Global Hawks were produced through a successful demonstration program that effectively and quickly provided the warfighter with transformational intelligence, surveillance, and reconnaissance capabilities. Defense Contract Management Agency reports, contract cost reports, corporate briefings, design drawing changes, new tooling and new production processes, and the evident need for Air Force and prime contractor task teams to be extensively deployed to subcontractor facilities, all indicate that the RQ-4B program entails higher degrees of risk, greater management challenges, and significant changes from production of the RQ-4A and earlier demonstrators.

We believe that our recommendation to delay further procurement of the RQ-4B until a new knowledge-based and risk-reducing business case is prepared prudently balances real-world internal investment risks with military demands from real-world external events. The Air Force could have continued to deliver the capability of the Global Hawk that was the direct outgrowth of the demonstration program while allowing the sensor and radar technology time to mature before investing in a new larger and more risky Global Hawk program. This would have allowed continued delivery of the enhanced RQ-4A capability to the warfighter while minimizing the impacts of design changes that come out of normal development and testing and that grow more costly as a product enters the production environment. The heavy cost of design changes after production is underway could impact DOD's ability to respond to other warfighter needs in the post-9/11 world.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from its issue date. At that time, we will send copies to interested congressional committees, the Secretary of Defense, the Secretary of the Air Force, the Secretary of the Navy, and the Director, Office of Management and Budget. In addition, the report will be available on the GAO Web site at http://www.gao.gov.

If you or your staff has any questions concerning this report, please contact me at (202) 512-4163 or Michael J. Hazard at (937) 258-7917. Other staff making key contributions to this report were Lily J. Chin, Bruce D. Fairbairn, Steven M. Hunter, Matthew B. Lea, Charlie Shivers, and Adam Vodraska.



Michael J. Sullivan
Director (Acting)
Acquisition and Sourcing Management

Scope and Methodology

To determine the effects of Global Hawk's restructuring on cost, schedule, and performance goals, we compared the original acquisition strategy, two major revisions, and the current acquisition strategy as implemented. We identified changes in cost, quantity, fleet composition, and sensor capability mixes as well as overall consequences of restructuring on total funding requirements, annual budget requests, and program cycles for developing, testing, and producing the Global Hawk. We reviewed management plans, cost reports, contract files, progress briefings, and risk data to identify program execution efforts and results to date. We identified cost changes, schedule delays, and performance issues.

To evaluate whether the current acquisition approach can help forestall risks, we applied GAO's methodology for assessing risks in major weapon systems. This methodology is derived from the best practices and experiences of leading commercial firms and successful defense acquisition programs. We reviewed program office and prime contractor organizations, processes, and management actions. We extracted and evaluated program and technical risks maintained in a risk database used by the program office and contractor to identify major risks and the steps taken to mitigate risks. We compared the program office's plans and results to date against best practice standards in achieving product knowledge in terms of technology, design, and production maturity information and in applying knowledge to support major program decisions. We identified gaps in product knowledge, reasons contributing to those gaps, and the elevated risks expected as a consequence of inadequate product knowledge. We further analyzed original and current acquisition approaches to demonstrate the high concurrency of development, production, and testing and the elevated risks imposed as a result.

In performing our work, we obtained information and interviewed officials from the Global Hawk System Program Office, Wright-Patterson Air Force Base, Ohio; 452nd Flight Test Squadron, Air Force Flight Test Center, and Detachment 5, Air Force Operational Test and Evaluation Center, Edwards Air Force Base, CA; Defense Contract Management Agency, San Diego and Palmdale, CA; Northrop Grumman Integrated Systems, Rancho Bernardo and Palmdale, CA; and offices of the Director, Operational Test and Evaluation, and Unmanned Aerial Vehicle Planning Office, which are part of the Office of the Secretary of Defense in Washington, D.C.

We conducted our work from February to September 2004 in accordance with generally accepted government auditing standards.

Comments from the Department of Defense

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

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

OCT 1 9 2004

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 AERIAL VEHICLES: Changes in Global Hawk's Acquisition Strategy Are Needed to Reduce Program Risks," dated September 17, 2004 (GAO Code 120296/GAO-05-6).

The DoD non-concurs with the draft report's recommendations. The Department is using the spiral development process to produce Global Hawk. This process allows risks to be understood and effectively managed. The GAO's more sequential development, test, analyze, and procurement process would delay, by several years, capabilities proven through our spiral development process, and increase overall program cost. The rationale for the DoD's position is attached.

The Department appreciates the opportunity to comment on the draft report. Technical comments were provided separately. For further questions concerning this report, please contact Dyke Weatherington, Deputy, UAV Planning Task Force, 703-695-6188.

Sincerely,

Glenn F. Lamartin
Director
Defense Systems

Enclosure:
As stated

Note: Page numbers in the draft report may differ from those in this report.

GAO Draft Report – Dated September 17, 2004
GAO CODE 120296/GAO-05-6

"UNMANNED AERIAL VEHICLES: CHANGES IN GLOBAL HAWK'S ACQUISITION STARTEGY ARE NEEDED TO REDUCE PROGRAM RISKS"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1**:** The GAO recommended that the Secretary of Defense direct the Air Force to revisit the decision to begin concurrent development and production of the Global Hawk "B" design. The GAO recommends that the direction should be for the Air Force to create and present a new business case that defines the warfighter's need and can be accommodated given current available resources of technology, engineering capability, time, and money (p. 18/GAO Draft Report).

DoD RESPONSE**:** Non-concur. The Global Hawk's evolutionary acquisition strategy balances acquisition risk with military need. The Department's intent is to rapidly field war-winning capability through the use of risk management as opposed to risk avoidance. As such, the business case that links the acquisition strategy to the warfighter's need is appropriate for this program.

By using the spiral development process, the Global Hawk program will achieve Initial Operating Capability approximately five years after program initiation, fielding even greater capability than initially planned. In addition, this process has enabled the Department to provide transformational war-winning capability (using Advanced Concept Technology Demonstration (ACTD) aircraft and ground stations) to on-going military operations without significant disruptions to on-going development and production activities. The GAO's more sequential development, test, analyze, and procurement process would delay, by several years, capabilities already proven through our spiral development process, and increase overall program cost.

The Department effectively manages Global Hawk program risk through regular oversight meetings with the Milestone Decision Authority (three in the last four years, with another planned for 2005), annual Selected Acquisition Reports, quarterly Defense Acquisition Executive Summary reports, and Monthly Activity Reports to the Service Acquisition Executive.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense delay further procurement of the Global Hawk "B", other than units needed for testing, until a new business case that reduces risk by using a knowledge-based acquisition strategy to justify further investment, is completed (p. 18/GAO Draft Report).

DoD RESPONSE: Non-Concur. The Department is effectively mitigating risk as it migrates from the single-intelligence RQ-4A configuration to the larger, multiple-intelligence RQ-4B configuration. The GAO asserts that without following its sequential knowledge-based approach (technology maturity, design maturity, production maturity), the Global Hawk program proceeds without the necessary knowledge to effectively manage risk. Global Hawk's spiral development acquisition strategy in fact fosters efficiency, flexibility, creativity, and innovation, and is designed to include the necessary controls the Department considers essential to manage program risk, achieve effective program results, and continue delivering transformational war-winning capability to on-going military operations.

The report incorrectly characterizes RQ-4B development risk. The RQ-4B is a larger configuration of the successful RQ-4A airframe. This is an evolutionary design change, and not a new airframe as the GAO asserts. The Department's seven ACTD and four production RQ-4A aircraft provide significantly improved "knowledge-based decision points" for the RQ-4B configurations. Over 4,960 RQ-4A flight hours, extensive RQ-4B wind tunnel data, and other testing results reflect a level of airframe knowledge more representative of a configuration update than a new airframe development. The Department verified the RQ-4A design model through flight-testing and then used it for RQ-4B design validation. While the redesign work represents a significant amount of effort, the aircraft updates are not technically challenging. The RQ-4B uses a larger wing (with the same airfoil), larger V-tail, slightly longer fuselage, and the same RQ-4A engine – the prime contractor successfully performed all of these design tasks for the RQ-4A, and, again, they are not technically challenging.

The report incorrectly relates the number of changed engineering drawings to the level of redesign complexity. The number of updated drawings is as much influenced by configuration management administrative requirements as by actual redesign effort. Risks associated with the RQ-4B's design and manufacturing preparations have been mitigated. The prime contractor's confidence in building the RQ-4B was demonstrated when they accepted a firm fixed price production contract for the first RQ-4B lot.

The report also inaccurately assumes that the RQ-4B aircraft, and the Advanced Signals Intelligence Program (ASIP) and Multi-Platform Radar Technology Insertion Program (MP-RTIP) sensors, must all succeed on schedule or the program will fail. The Department takes exception to this high-risk characterization. Should a sensor program diverge from its current plan, the more likely course of action would reflect effective oversight and action. The RQ-4B's payload capacity is a valuable resource for planned and alternate future payloads. If necessary, payload configurations can be adjusted to balance risk, resources, and military need.

While not addressed in detail, the report's evaluation of the two advanced sensor programs – MP-RTIP and ASIP – appears out of step with our understanding of the technical and programmatic risks. The Department agrees that related and major acquisition programs pose significant acquisition management challenges. We have accepted that challenge as the price of fielding technologically superior weapon systems. Fielding the RQ-4B with the MP-RTIP and ASIP capabilities on a realistic schedule will require continued, coordinated and comprehensive management oversight by the Department.

The MP-RTIP program fully addresses the risks associated with a major sensor development effort. The report overstates risk related to this new radar capability. In particular, the Department's December 2002 program approval ensures significant ground and flight test activity occurs before production decisions are made. The close management and technical working arrangement of the Global Hawk and MP-RTIP contractors ensures that critical platform and radar interface definitions are established at the earliest date possible to produce the maximum synergy. Additionally, as a risk reduction move, MP-RTIP will first be integrated and flown in a Global Hawk configuration on the Proteus in FY07, a high altitude manned aircraft. This activity is specifically designed to reduce risk for integration onto the Global Hawk.

The ASIP acquisition is managed by an office dedicated to developing and deploying multiple sensor and electronic payloads in a variety of aircraft. The ASIP sensor evolved from a previous successful signals intelligence payload and is an evolutionary acquisition of that technology. The ASIP and Global Hawk programs benefit from being organized into the same Capability Wing within AFMC and housed in the same building. This close association results in better harmonization of program requirements and development than reported. ASIP will first be integrated and flown on the high altitude U-2 manned aircraft in the summer FY07. This affords the Global Hawk program another significant risk reduction step for this system.

The report recommendation results in a production break without addressing impacts of that action. In fact, the Department has determined a production break would have a significant negative impact in cost and capability. The contractor's rough estimate of the quantifiable impact is about $400 million (then year dollars). Not included in this rough estimate is the likely catastrophic financial impact to small business vendors and subcontractors, and costs to mothball and restart production facilities. The United States could lose its leadership role in strategic unmanned aerial vehicles as multiple interested foreign partners would likely look to themselves, or elsewhere, for a more reliable source. Finally, delaying or stopping production of the RQ-4B creates a gap for the warfighter by delaying the fielding of critical IMINT and SIGINT capability to the warfighter. The negative impact of this capability loss is also not addressed in the report.

Finally, the report's sequential, knowledge-based approach does not consider real world, external environmental inputs such as 9/11, North Korea, and Iraq. The Department selected the Global Hawk program as a transformational weapon system based on a determination that real world events required a rapid and significant increase in ISR capability. Subsequent military actions validated our forward-thinking decision and the need to rapidly field ISR capability.

Knowledge Gaps at Critical Knowledge Points

Technology Maturity Gap—Knowledge Point 1

Achieving a high level of technology maturity at the start of system development is a particularly important best practice. This means that the critical technologies needed to meet essential product requirements are in the form, fit, and function needed for the intended product and have been demonstrated to work in their intended environment. The RQ-4B development program is struggling to meet these criteria for several of its most critical technologies. More than 2 years after development began, the technologies required for the RQ-4B to perform its operational mission including enhanced imaging sensors, signals intelligence, multiplatform radar, and open system architecture are immature, basically at a functional rather than form or fit configuration. Nevertheless, the Air Force continues to build the RQ-4B platform, lacking solid assurance that these critical subsystems will work as planned.

In particular, the airborne signals intelligence payload and multiplatform radar technology insertion program are still in development under separate Air Force programs and will be purchased by the Global Hawk program as government furnished equipment. These subsystems are key to providing the advanced intelligence, surveillance, and reconnaissance capabilities for which the RQ-4B is being developed. At the time of our review, neither of these technologies had been demonstrated in an operational environment using a system prototype. Air Force officials characterized their current stages of development as laboratory settings demonstrating basic performance, technical feasibility, and functionality but not form or fit (size, weight, materials, etc.). Technology maturity of the sensors is critical because the basic design of the RQ-4B has been completed and allocates limited space, weight, and power for the new capability. If the new sensors cannot be developed within these constraints, some performance trade-offs—such as reduced frequency coverage—are likely. The airborne signals intelligence payload currently exceeds the weight allocated for its integration into the RQ-4B, while the multiplatform radar uses most of the vehicle's available power-generation capability.

Officials expect them to be mature by the time they begin buying sensors to incorporate them into the Global Hawk production line in fiscal years 2008 and 2009. However, by this time most of the air vehicles will have already been bought; additional time and money might be needed to fix or retrofit any remaining differences. Also, operational testing to evaluate performance in a realistic operating environment is not scheduled until late fiscal year 2008 for the signals intelligence sensor and late 2010 for the radar. Any changes or delays in these programs would likely impact Global Hawk cost, schedule, and/or performance.

Design Maturity Gap—Knowledge Point 2

Seventy-five percent of engineering drawings were released at the Global Hawk design readiness review that triggered the start of RQ-4B manufacturing and assembly. This figure is 15 percent less than the best practices' standard of 90 percent. The Air Force and contractor had anticipated being able to use much of the design work and production experience on the RQ-4A to prove the design and decrease the time and extent of engineering work on the RQ-4B. However, officials found out that the two models had much less in common than anticipated. About 90 percent of the airframe had to be redesigned—only 10 percent was common to both models. Therefore, relying on the experience of the RQ-4A increased the risk of poor program outcomes because the RQ-4B is substantially heavier; incorporates a new wing, fuselage, and vertical tail; has a 50 percent greater payload capacity to carry advanced sensors still in development; and requires new production tooling, new materials, and changed manufacturing processes.

The Air Force also did not build an RQ-4B prototype—a best practice to demonstrate design stability—before awarding a contract to start production. An analysis of the development contract performance, as of May 2004, shows that development and integration efforts needed to finalize the design and prepare the RQ-4B for production is behind schedule and over cost. The planned work efforts were just over one-half completed, but two-thirds of the budget allocated for these efforts was expended. Defense Contract Management Agency analysts cited cost growth in labor and materials and problems in finalizing and releasing design drawings as causes for the problems.

Neither the original nor the current plan established comprehensive reliability targets and growth curves. Reliability growth is the result of an iterative design, build, test, analyze, and fix process. Improvements in reliability of a product's design can be measured by tracking reliability metrics and comparing the product's actual reliability with the growth plan and, ultimately, to the overall goal. Although both models are in production, the Air Force did not establish reliability growth programs to measure how reliability is improving and to uncover design problems so fixes could be incorporated before the design was frozen and before committing to production.

Production Maturity Gap—Knowledge Point 3

Officials have started to identify the critical manufacturing processes for the RQ-4B but do not intend to collect and use statistical process control data to ensure that the manufacturing could deliver quality products within best practices quality standards and that the end product meets the design and specifications. The officials' assessments of the program continue to identify significant concerns about the quality, performance, and timeliness of the work of several subcontractors. For example, the subcontractor building the vertical tail and main parts of the fuselage is new to large-scale manufacture using advanced composite materials. The firm experienced significant start-up problems and the prime contractor and DOD sent special teams of advisors to help develop the firm's manufacturing processes and to train employees. The subcontractor's critical processes must be demonstrated to ensure good quality and limit rework. Officials have identified similar concerns with the subcontractors building the wing and imaging sensor.

The Air Force started producing the A and B models without first demonstrating that the systems would meet reliability goals. Reliability is a function of the specific elements of a product's design and making changes after production begins is costly and inefficient. Best practices for system development require reliability to be demonstrated by the start of production. The RQ-4A is a production version of the demonstrators with few changes. Testing of the demonstrators identified a need to evaluate reliability under a stressful operating tempo. Air Force officials told us that reliability improvements on the RQ-4A were constrained, as were demonstrations of reliability. The RQ-4B design has incorporated improvements in such areas as flight control actuators, mission computers, avionics, and structures that officials expect will fix some of the identified problems and improve reliability, but these have not been demonstrated.

Finally, the Air Force did not acquire and test a fully integrated system representative prototype before committing to production. The contract for the first three units was awarded and work began in late fiscal year 2004. Budget plans call for procuring 13 RQ-4Bs in low-rate production through the fiscal year 2006. The Air Force has also programmed advance procurement funds in fiscal year 2006 for 7 more, meaning that the government will have made investments in 20 RQ-4Bs—45 percent of the entire RQ-4B fleet—before the basic air vehicle is flight tested and before evaluations are made leading to the full-rate production decision, scheduled in fiscal year 2007. The Air Force also plans to enter full-rate production without complete testing to demonstrate that a fully integrated system—with advanced sensors and data links—will work as intended, is reliable, and can be produced within cost, schedule, and quality targets. Initial operational test and evaluation will only test the RQ-4B air vehicle with its basic imagery intelligence payloads. Complete operational testing and incorporation of the advanced signals intelligence payload and the multiplatform radar capabilities—the reasons for acquiring the larger model in the first place—will not occur until later in the program, after the full-rate decision is made.

In the absence of specific product knowledge required by best practices and DOD acquisition guidance, the Air Force and its contractor are depending on the operational experience of the demonstrators, lab modeling and simulation efforts, and production of the RQ-4A to help "close the gaps" and provide some assurance on the RQ-4B design maturity, its reliability, and its producibility within cost, schedule, and quality targets. Although the demonstrator program had notable successes, testing identified significant improvements were needed before producing operationally effective and suitable air vehicles. Areas needing improvement included reliability under a stressful operating tempo, performance of sensors, mission planning, and communications bandwidth burden. We also note that the RQ-4A is a production version of the demonstrators with few changes and that government acceptance of the second production RQ-4A was delayed due to deficiencies, including flight problems. Moreover, as previously discussed, the RQ-4B is significantly different than the RQ-4A and requires investing in new tooling and changed manufacturing processes. These factors contribute to increased risks of poor cost, schedule, and performance outcomes due to incomplete product knowledge.

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