

**GAO**

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

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June 2003

# DEFENSE ACQUISITIONS

## Matching Resources with Requirements Is Key to the Unmanned Combat Air Vehicle Program's Success





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Matching Resources with Requirements Is Key to the Unmanned Combat Air Vehicle Program's Success

Highlights of GAO-03-598, a report to the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The Department of Defense (DOD) is developing a new unmanned combat air vehicle (UCAV) that can suppress enemy air defenses and conduct other air-to-ground attacks, particularly against heavily defended targets. Because it may perform these missions at a relatively low cost, the UCAV could be used to replace some of DOD's aging tactical aircraft fleet. A key to UCAV's success will lie in DOD's ability to match users' needs, or requirements, with the developer's resources (technology and design knowledge, money, and time) when product development begins. Our work shows that doing so can prevent rework and save both time and money. Therefore, we assessed DOD's ability to make this match. GAO conducted its work on the basis of the Comptroller General's authority and addresses the report to the Subcommittee because of its interest and jurisdiction in the program.

What GAO Recommends

We recommend that DOD develop a joint UCAV acquisition approach that balances requirements and resources at the start of product development. We also recommend that the Secretary formalize the UCAV management role performed by his office, ensure that the services are fully involved in the process, and work to develop an efficient approach to transition the UCAV to the product development phase so the needs of the war fighter can be met more quickly.

[www.gao.gov/cgi-bin/getrpt?GAO-03-598](http://www.gao.gov/cgi-bin/getrpt?GAO-03-598).

To view the full product, including the scope and methodology, click on the link above. For more information, contact Paul Francis at (202) 512-2811 or francisp@gao.gov.

What GAO Found

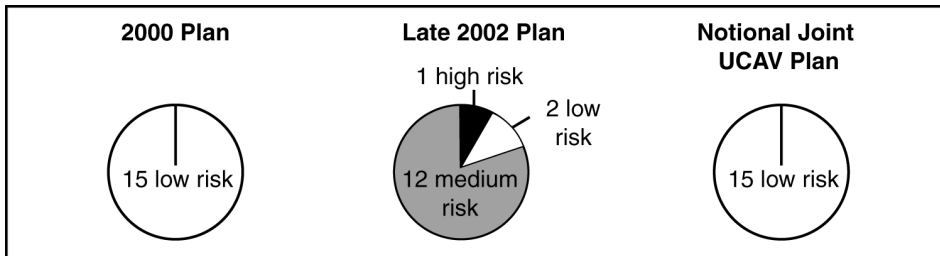
The UCAV program's original performance objectives posed manageable challenges to build an affordable, highly survivable, and lethal weapon system. The Air Force, however, added requirements for electronic attack and increased flying range after DOD accelerated the program's product development schedule by 3 years. These changes widened the gap between the customer's requirements and the developer's resources, specifically time, reducing the probability that the program would deliver production aircraft on cost, on schedule, and with anticipated performance capabilities.

DOD has recently decided to adopt a new joint service approach to UCAV development that provides more time to close the requirements—resource gap before product development starts. It appears DOD may add new content because it is proposing to build a new prototype that would be a larger air vehicle, capable of flying and carrying out combat missions for longer periods of time. To reduce technical risk, DOD anticipates delaying the start of product development for several years in order to address new requirements.

As a gap between resources and requirements widened in 2002, risks projected for the start of product development with UCAV's 15 technologies, processes and system attributes increased significantly. The new joint plan brings the risks back down. This action also allows competition back into the UCAV development effort.

DOD will still face challenges in controlling joint, multimission requirements and ensuring that both services continue to provide funds for the program while also funding other large aircraft investments. If these challenges are not met, the gap between requirements and resources could resurface. DOD's role will continue to be instrumental in helping to negotiate requirements, assure resources are in place, and make difficult program trade-offs.

Risk Levels Projected at Start of Product Development under Different UCAV Plans



Source: GAO analysis.

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## **Abbreviations**

DARPA	Defense Advanced Research Projects Agency
SEAD	suppression of enemy air defenses
UCAV	Unmanned Combat Air Vehicle

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G A O

Accountability \* Integrity \* Reliability

United States General Accounting Office  
Washington, DC 20548

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June 30, 2003

The Honorable Curt Weldon  
Chairman  
The Honorable Neil Abercrombie  
Ranking Minority Member  
Subcommittee on Tactical Air and Land Forces  
Committee on Armed Services  
House of Representatives

The Department of Defense (DOD) is in the initial stages of developing a new unmanned air vehicle capable of suppressing enemy air defenses and carrying out other types of air-to-ground attacks, particularly against heavily defended targets. Because of its potential to perform these missions at a relatively low cost, this new air vehicle could foster efforts to replace DOD's aging tactical aircraft fleet.

The air vehicle is being developed under the Unmanned Combat Air Vehicle (UCAV) program. This is an advanced technology demonstration program, still in a pre-acquisition phase, with two demonstrator UCAVs being flown to assess technologies and capabilities. Launch of a formal product development program was expected to occur next fiscal year but has since been delayed. We conducted our work on the basis of the Comptroller General's authority and have addressed the report to you because your expressed interest in the program as a committee of jurisdiction.

The start of product development—signified by a Milestone B decision—represents the point at which program managers make a commitment to DOD and the Congress that the UCAV will perform as required and be delivered on time and within estimated costs. Our work has shown that programs are more likely to succeed if program managers are able to achieve a match between user needs, which eventually become requirements, and resources (technology, design and production knowledge, money, and time) at the start of product development. Conversely, if they do not match requirements with resources, cost overruns and schedule delays are likely to occur, reducing DOD's buying power in other areas.

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Consequently, this report analyzes requirements<sup>1</sup> and schedule changes made during pre-acquisition and their effects on DOD's ability to achieve this match. The report also assesses a recent decision to expand the program—both in terms of the military services that will be involved with it and in terms of the design and capability of the air vehicle—and that decision's effect on DOD's ability to match requirements to resources.

Our report focuses on the UCAV program managed by the Air Force and the Defense Advanced Research Projects Agency (DARPA). DARPA has also been working with the Navy on a UCAV, but until recently its transition to the product development phase was further off in the future. We did not assess the Navy's effort except to the extent that it was included in the recently established joint program.

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## Results in Brief

From 2000 through 2002, decisions to get more capability in less time widened the gap between UCAV resources and requirements. The UCAV program's original requirements posed significant, but manageable challenges to build an air vehicle that is affordable throughout its life cycle, highly survivable, and lethal. Subsequently, however, the Air Force added requirements for an electronic attack mission and increased flying range. Also, DOD accelerated the program's product development schedule by 3 years. Those actions widened the gap between requirements and resources and increased the challenge for the development program.

DOD has recently decided to adopt a new joint Air Force and Navy approach to UCAV development that provides more time to close the requirements-resource gap before product development starts. Details concerning the new acquisition strategy behind this approach have not yet been worked out. However, the program could increase requirements since DOD is proposing to develop a new prototype that would essentially be a larger air vehicle, capable of carrying out combat missions for longer periods of time. DOD currently anticipates delaying product development by several years in order to address new requirements. This delay would help to reduce technical risks, but initial fielding of the new air vehicle would be delayed as well. Having the Air Force and the Navy work jointly on a UCAV program is more efficient than two separate programs. At the

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<sup>1</sup> Formal requirements for the UCAV program have not yet been established. However, program objectives based on customer expectations have been established for specific missions the UCAV is expected to perform. We refer to these as requirements in this report.

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same time, the participation of two services will increase the challenges of sustaining funding and managing requirements.

GAO is making recommendations to the Secretary of Defense on maintaining flexibility to make the tradeoffs necessary to bring and keep the UCAV's requirements and resources in balance and to ensure his office maintains the constructive role it has played in the program so far.

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## Background

DOD has been successfully using unmanned air vehicles such as the Global Hawk and Predator to gather intelligence and perform surveillance and reconnaissance missions for military purposes. Beginning in the mid-1990s, DOD began to conceive of a different type of unmanned air vehicle—the unmanned combat air vehicle or UCAV—which would be capable of performing dangerous, lethal combat missions, including suppression of enemy air defenses (SEAD).<sup>2</sup> Unlike other unmanned air vehicles, UCAVs would carry weapons as well as electronic jammers to confuse enemy radars. DOD also envisioned that the air vehicle would operate more autonomously than other unmanned air vehicles, requiring little or no human input from ground stations to complete their missions or change flight paths. In addition, UCAVs would be stealthy and capable of flying in groups or with manned aircraft.

The potential of these weapons has garnered high interest from both Congress and DOD. In the fiscal year 2001 Defense Authorization Act, Congress set a goal that by 2010, one-third of DOD's deep strike force be unmanned in order to perform this dangerous mission.<sup>3</sup> In addition to the potential for saving lives on risky missions, the UCAV could provide mission capability at less cost than manned aircraft. Program officials initially aimed for the UCAV's acquisition cost to be one-third of the joint strike fighter and operations and support costs to be at least 75 percent lower. Because of the promise of unmanned air vehicles, the Office of Secretary of Defense has established a joint-service unmanned air vehicles task force to help promote the development and fielding of these systems, including making sure that there is multiservice cooperation. This task

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<sup>2</sup> Suppression of enemy air defenses (SEAD) missions are those directed at destroying or interrupting the ability of ground-based missiles, either fixed or mobile, to locate, target, and/or destroy U.S. aircraft.

<sup>3</sup> Pub. L. No. 106-398, Sec. 220 (2000).

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force is responsible for outlining the future of DOD's unmanned air vehicles.

In the late 1990s, DARPA and the Air Force began pre-acquisition efforts to conduct advanced technology demonstrations to show the technical feasibility of using UCAVs to penetrate deeply into enemy territory to attack enemy targets. Boeing Corporation was selected in 1999 to develop and demonstrate two demonstrator UCAVs—designated X-45A. (See fig. 1.)

**Figure 1: Boeing X-45A Demonstrator in Flight**



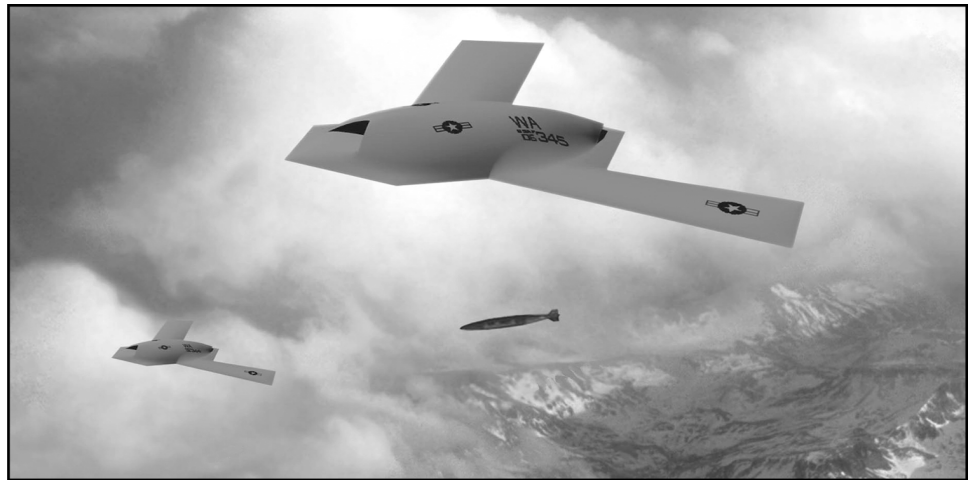
Source: DOD.

The DARPA-Air Force UCAV original plan also called for building and demonstrating two prototypes during the pre-acquisition phase, called X-45B, that are larger and incorporate low observable technology. (See fig. 2.) These air vehicles were expected to be more representative of the operational air vehicle that the Air Force planned to field. Initially, the Air Combat Command, which establishes mission and performance requirements, determined that the X-45B should be focused on performing SEAD missions within the air superiority mission area. This decision was made to address the limited inventory of current assets in the air superiority mission area and to counter the challenges and deficiencies associated with conducting SEAD missions.



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**Figure 2: Computer Rendition of the Boeing X-45B Prototype**



Source: DOD.

As of February 2003, 55 of 160 planned demonstrations have been completed. Most of the demonstrations designed to validate the basic flight characteristics of the air vehicle have been completed. Only a small number of the demonstrations needed to validate the ability of a single air vehicle to perform a preemptive destruction mission have been completed. The more demanding demonstrations—those designed to demonstrate technologies and software for highly autonomous, multivehicle operations (with both manned aircraft and unmanned air vehicles), and the more difficult aspects of the SEAD mission against mobile targets—have not begun.

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## Importance of Matching Resources with Requirements before Product Development

The product development decision that DOD is approaching for its UCAV program represents a commitment by the product developer to deliver a product at established cost, schedule, and performance targets and identifies the amount of resources that will be necessary to do so. Our studies of leading companies have shown that when requirements and resources were matched before product development was started, the more likely the development was able to meet performance, cost, and schedule objectives.<sup>4</sup> When this took place later, programs encountered

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<sup>4</sup> U.S. General Accounting Office, *BEST PRACTICES: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, [GAO-01-288](#) (Washington, D.C.: Mar. 8, 2001).

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problems such as increased cost, schedule delays, and performance shortfalls.

A key to achieving this match is to ensure that the developer has the resources—technology, design and production knowledge, money, and time—needed to design, test, manufacture, and deliver the product. It is not unusual for a customer to initially want a high-performing product that does not cost much or take too long to develop. But such an expectation may exceed the developer’s technology or engineering expertise, or it may be more costly and time-consuming to create than the customer is willing to accept. Therefore, a process of negotiations and trade-offs is usually necessary to match customer requirements and developer resources before firming requirements and committing to product development. Our work has shown that successful programs will not commit to product development until needed technologies are ready to satisfy product requirements. In other words, technology development is separated from product development. If technology is not sufficiently mature at the beginning of a product development program, the program may need to spend more time and money than anticipated to bring the technology to the point to which it can meet the intended product’s performance requirements.<sup>5</sup>

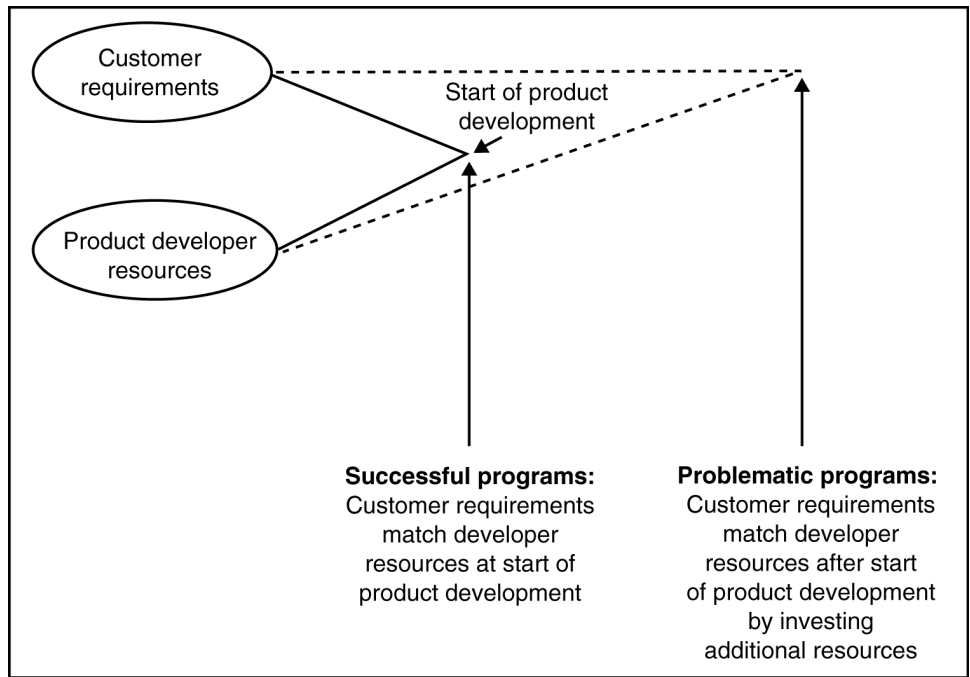
Testing is perhaps the main instrument used to gauge technology maturity. Testing new technologies before they enter into a product development program, as DOD is doing now by demonstrating the two X-45A demonstrators, enables organizations to discover and correct problems before a considerable investment is made in the program. By contrast, problems found late in development may require more time, money, and effort to fix because they may require more extensive retrofitting and redesign as well as retesting. These problems are further exacerbated when the product development schedule requires a number of activities to be done concurrently. The need to address one problem can slow down other work on the weapon system.

Figure 3 illustrates the timing of the match between a customer’s requirements and a product developer’s resources for successful and problematic programs we have reviewed.

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<sup>5</sup> U.S. General Accounting Office, *BEST PRACTICES: Better Management of Technology Development Can Improve Weapon System Outcomes*, [GAO/NSIAD-99-162](#) (Washington, D.C.: July 30, 1999).

**Figure 3: Timing of the Match between Customer Requirements and Resources**



Source: GAO.

## Gap between UCAV Resources and Requirements Was Increased in 2002

During 2002, significant requirements were added to the UCAV program after the schedule was accelerated by 3 years. This step put the program at considerable risk because it increased the gap between requirements and resources. The program added two new requirements—one for electronic attack capability and one for increased flying range—while reducing a critical resource, time, to mature key UCAV technologies. As a result, the Air Force and DARPA anticipated that most of the 15 key technologies, system attributes, or processes supporting the aircraft's basic capabilities would move from all low risk to mostly medium risk of achieving desired functionality by the time a product development decision was reached; one would be at high risk.

## UCAV Requirements Increased During 2002

The UCAV program's original requirements were difficult to meet because they posed significant but manageable technical challenges to building an air vehicle that is, at once, affordable throughout its life cycle, highly survivable, and lethal. In the last year, both air vehicle and mission

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equipment requirements were increased. The original requirements called for a UCAV that would have

- a low life-cycle cost, survivable design;
- a mission control station that can fly single or multiple UCAVs at one time;
- a secure command, control, and communications network;
- completely autonomous vehicle operation from takeoff to landing;
- off-board and on-board sensors with which to locate targets; and
- human involvement in targeting, weapons delivery, and target damage assessment.

Once these requirements were established, the UCAV contractor identified 15 technologies, processes, and system attributes the UCAV would have to possess to meet those requirements. These elements became a way to gauge the level of knowledge (in terms of risk) that the contractors had. Right now, technologies that support some of these capabilities, such as autonomous operation, are not yet mature. We used their risk assessments and criteria for the 15 technologies, processes, and system attributes to determine current system integration risk as well as technology risk. We believe technology readiness levels would have provided a more precise gauge of technology maturity, but program officials did not provide them.<sup>6</sup> Currently, 10 technologies, processes, and system attributes are considered to be medium risk by the Air Force and DARPA. Medium risk means that there is a 30 to 70 percent probability of achieving the desired functionality for the initial operational UCAV. Moreover, 5 are currently considered to be high risk, that is, there is less than 30 percent probability of achieving their functionality. Table 1 provides the current risk level of the 15 UCAV technologies, processes, and system attributes for original UCAV objectives.

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<sup>6</sup> A good indicator of technology risk is technology readiness level, which is used by NASA and some Air Force programs to define the level of risk from a technology given its level of demonstration.

**Table 1: Current Risk Level of UCAV Technologies, Processes, and System Attributes**

<b>Characteristics currently at medium risk</b>	<b>Characteristics currently at high risk</b>
<ul style="list-style-type: none"> <li>Affordable air vehicle unit/recurring flyaway cost</li> </ul>	<ul style="list-style-type: none"> <li>Survivable air vehicle integration</li> </ul>
<ul style="list-style-type: none"> <li>Weapons suspension and release</li> </ul>	<ul style="list-style-type: none"> <li>Advanced targeting and engagement process</li> </ul>
<ul style="list-style-type: none"> <li>Dynamic distributed mission/vehicle control</li> </ul>	<ul style="list-style-type: none"> <li>Low observable maintainability</li> </ul>
<ul style="list-style-type: none"> <li>Advanced cognitive aids integration, mission planning</li> </ul>	<ul style="list-style-type: none"> <li>Adaptive, autonomous operations</li> </ul>
<ul style="list-style-type: none"> <li>Force integration, interoperability, and information assurance</li> </ul>	<ul style="list-style-type: none"> <li>Affordable large-scale software</li> </ul>
<ul style="list-style-type: none"> <li>Secure, robust communication capability</li> </ul>	
<ul style="list-style-type: none"> <li>Coordinated multivehicle flight/motion</li> </ul>	
<ul style="list-style-type: none"> <li>Affordable operating and support cost, and integrated vehicle health management</li> </ul>	
<ul style="list-style-type: none"> <li>Mobility, rapid deployment, and footprint</li> </ul>	
<ul style="list-style-type: none"> <li>Sortie rate, turn time, and ground Operations</li> </ul>	

Source: DOD.

Originally, the UCAV program was tasked with providing an air vehicle that would perform both preemptive and reactive SEAD missions against fixed and mobile targets that are extremely demanding from both a mission and capability perspective. The reactive mission is more demanding than the preemptive mission because the UCAV will have less time to find and engage mobile targets. When DOD decided to accelerate delivery of the initial UCAVs, the program was relieved of meeting the requirement for reactive SEAD, making for a better balance between requirements and available resources. However, requirements were subsequently added that increased the challenge of matching requirements with resources. These requirements include an electronic attack mission and increased combat range and endurance.

- Electronic attack: DOD’s electronic attack mission is currently performed by the Navy’s aging EA-6B Prowler aircraft. Electronic attack confuses enemy radars with electronic jammers. In 2001, the Navy conducted an analysis of alternatives for replacing the Prowler.

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Air Combat Command planners determined that the UCAV could fill portions of this role quickly and added the requirement to the program. As currently structured, the program does not plan to demonstrate electronic attack technologies on UCAV demonstrator or prototype vehicles before product development begins. According to program officials, the biggest additional challenge associated with this change is the integration of existing electronic attack technologies into a low observable air vehicle. Program officials are also concerned that downsizing and repackaging current electronic warfare technology to fit into a smaller space, with sufficient cooling and power, and incorporating antennas and other apertures into the low observable signature of the UCAV may pose additional challenges. Program officials also stated that the addition of electronic attack adds uncertainty to overall program costs. It may reduce the number of initial UCAVs planned for initial production because additional work will be required to integrate this capability into air vehicles, given the current schedule and funding.

- Longer range and endurance: According to program officials, Air Force leadership would like to have a larger UCAV with longer range and greater endurance than that currently being designed in the X-45B to perform strategic lethal strike and nonlethal intelligence, surveillance, and reconnaissance missions. However, increasing UCAV's range forced the program to abandon a key design concept expected to lower operating and support costs significantly over that of a manned aircraft—one of the program's original critical requirements. The initial UCAV concept was a design that allowed the wings to be detached from the air vehicle and stored in a crate for up to 10 years, a concept which was expected to contribute to a greater than 75 percent reduction in operation and support costs. When needed, the UCAV could be shipped to the theater of operations, assembled, and readied for use. Adding range and endurance required redesigning the air vehicle with fixed or permanently attached wings, in order that the inside of the wings could be used as fuel tanks. This would allow the UCAV to carry more fuel and give it the ability to fly farther. Since the wings would no longer be detachable, the long-term storage approach had to be abandoned.

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### Schedule Compression Created Greater Technical and Cost Risks

The schedule for the UCAV program has changed several times during the pre-acquisition phase. In 2000, the Air Force anticipated that product development would start in 2007 and initial deliveries would begin in 2011. After several schedule changes, the Air Force set product development in 2004 and initial delivery of aircraft in 2007. (See table 2.) The net effect of

the changes was a 3-year reduction in time to mature technologies before product development. This reduction created the potential for costly and time-consuming rework in product development since the Air Force would still be in the process of maturing technologies as it undertook other product development activities. Moreover, the concurrency that comes with the schedule changes would have left little room for error.

**Table 2: Chronology of Changes to the Air Force UCAV Acquisition Program Schedule Since 2000**

Program strategy as of	End of technology and military utility demonstrations (FY)	Start product development (FY)	Initial deliveries (FY)	UCAV capabilities
2000	2007	2007	2011	Preemptive SEAD; reactive SEAD
2001	2006	2005	2010	Preemptive SEAD; reactive SEAD
Explanation of change: To meet Air Force expectations for delivering capabilities to the war fighter earlier than 2011, the product launch date was moved up by 2 years to 2005 and initial delivery up 1 year to 2010.				
2002	2006	2003	2007	Preemptive SEAD
Explanation of change: The schedule was changed by direction of the Office of the Secretary of Defense to further accelerate delivery of initial operational UCAVs to the customer. The program attempted to balance this decision by deferring the most challenging requirements for conducting reactive SEAD against mobile targets to a future version of UCAV.				
Late 2002	2006	2004	2007	Preemptive SEAD; Electronic attack; Extended range
Explanation of change: The timeline was changed to address added requirements for electronic attack and extended range. While 1 year was added to the start of product development, the date for initial deliveries did not change.				

Source: GAO presentation of program data.

Under the original schedule, the UCAV program would essentially have 3 more years prior to the beginning of product development to test and mature technologies. As a result, all 15 of the technologies, processes, and system attributes would be at low risk by the launch of product development indicating a match between requirements and resources. By contrast, under the late 2002 schedule, the program would not have enough time to mature technologies to a low risk prior to the launch of product development in 2004. In fact, most technologies, processes, and system attributes would still be either medium or high risk by the time product development was launched indicating that requirements exceeded resources.

The overlap of technology development and product development, introduced by the acceleration of product development, also raised risks for the UCAV program. The late 2002 schedule allowed less time for discovering and correcting problems that may have arisen during

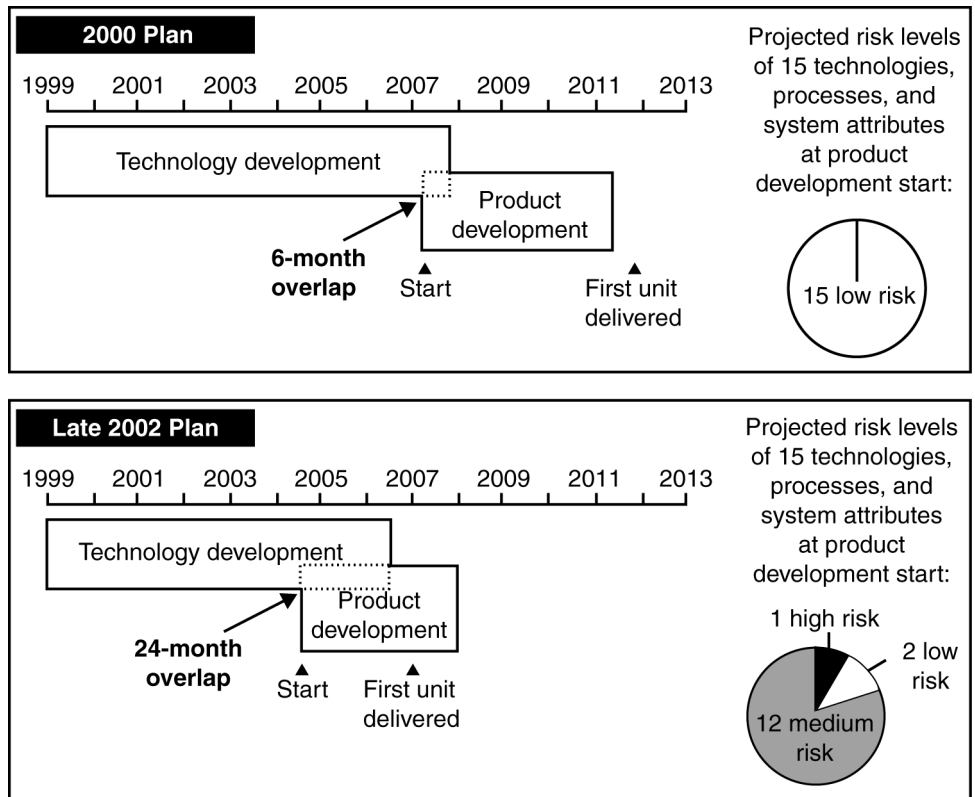
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technology demonstrations prior to product development launch. Importantly, all of the air vehicle military utility demonstrations would have been completed after the beginning of product development. Under the original schedule most of these demonstrations would have been completed prior to the start of product development.

Increasing the overlap of technology development and product development added risk to the program. Problems found during those demonstrations might have to be fixed during product development—problems made more likely given the lower maturity level of the key technologies. Figure 4 shows that the concurrency between technology development and product development increased by approximately 18 months under the late 2002 schedule—from a 6-month approximate overlap to a 24-month approximate overlap. Also, this acceleration increased the program risk for the start of product development from all low to mostly medium risk for the 15 technologies, processes, and system attributes being tracked.



**Figure 4: Effect of Accelerated Product Development Start on Program Risk**



Source: GAO analysis.

As figure 4 indicates, the UCAV technology and product development phases had been shortened from a plan with little concurrency between technology and product development to a plan with significant concurrency between the two. The push to deliver the product sooner compressed the time in which technologies will be matured and integrated into the UCAV weapon system. The resulting approximate 24-month overlap between technology and product development caused by accelerating the beginning of UCAV's product development program had the potential to create "late cycle churn," or the scramble to fix significant problems discovered late. We have found that when problems are

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uncovered late in product development, more time and money is required to rework what is already finished.<sup>7</sup>

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## Recent DOD Decision to Restructure Program Can Reduce Risks

The Office of the Secretary of Defense recently restructured the UCAV program to a joint program structure to meet the needs of the Navy as well as the Air Force. The Office of the Secretary of Defense cancelled plans to build the X-45B prototypes and now anticipates that the joint UCAV program will focus on a family of vehicles derived from the larger Boeing X-45C and Northrop Grumman X-47B prototypes designs. The details of the program are still being decided, but it appears likely that while content will increase, the start of product development will be delayed. This approach represents a substantial improvement over the late 2002 plan in that it lowers risks significantly. However, keeping requirements and resources in balance and funding intact until product development starts will be a challenge.

The proposed prototypes will be larger than the X-45A or X-45B and thus more capable of supporting requirements for greater combat range and endurance. Also, both the proposed X-45C and X-47B prototypes will have a larger wing area, allowing them to carry increased payload and internal fuel. Just as the X-45B would have been more capable than the X-45A, the X-45C is projected to be more capable than the X-45B as shown in Table 3 below. We did not obtain specific data on the X-47B prototype.

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**Table 3: Comparisons of UCAV Variants**

	<b>X-45A</b>	<b>X-45B</b>	<b>X-45C</b>
Weight	12,000 lb.	21,000 lb. (approx.)	35,000 lb.
Length	26.3 ft.	32 ft.	36 ft.
Wingspan	33.8 ft.	47 ft.	48 ft.
Payload	1,500 lb.	2,000 lb.	4,500 lb.
Ceiling	35,000 ft.	40,000 ft.	40,000 ft.
Speed	0.75 Mach	0.85 Mach	0.85 Mach
Endurance/combat radius	450 NM w/30 minutes loiter	850 NM w/30 minute loiter (w/added internal fuel)	1100–1300 NM w/30 minute loiter

Source: DOD.

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<sup>7</sup> U.S. General Accounting Office, *Best Practices: A More Constructive Test Approach Is Key to Better Weapon Systems Outcomes*, [GAO/NSIAD-00-199](#) (Washington, D.C.: July 31, 2000).

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Further, by adopting a design that increases internal space on the air vehicle, DOD could more readily incorporate electronic attack equipment and other sensors and avionics. In addition, the plan would reintroduce competition into the UCAV program by assessing two different designs. This competition would increase DOD's ability to pursue the best technical solution. On the other hand, acquisition cost for the larger air vehicles are expected to increase as will operating and support costs due to the abandonment of the storage-in-the-box concept. Also, meeting the Navy's need for carrier-based operations could place additional demands on the air vehicle design. Figures 5 and 6 show illustrations of Boeing and Northrop Grumman proposed joint UCAV designs.

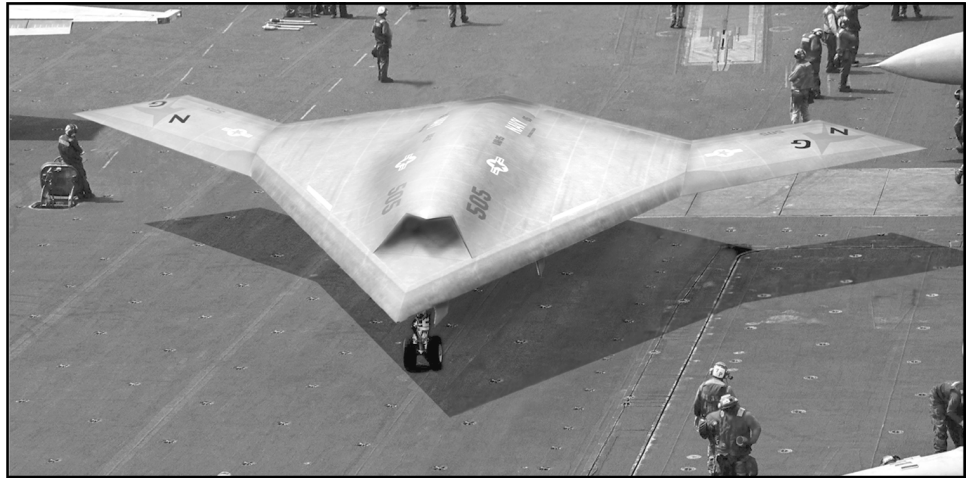
**Figure 5: Computer Rendition of the Boeing X-45C**



Source: DOD.

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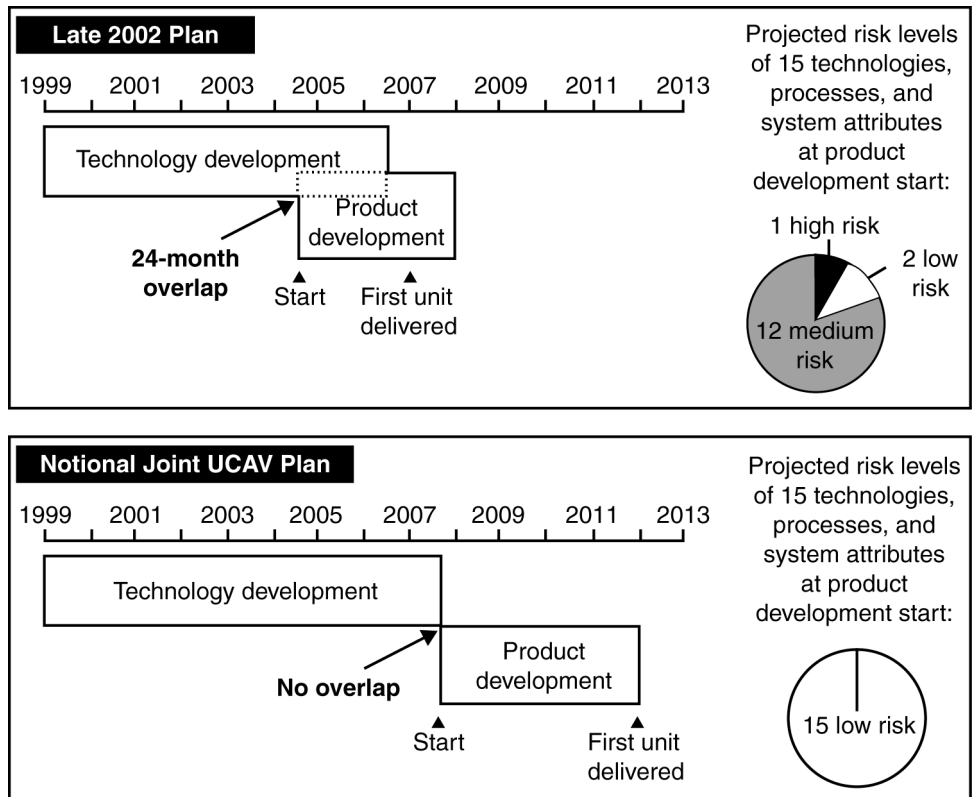
**Figure 6: Computer Rendition of the Northrop Grumman X-47B**



Source: DOD.

In addition, more time will be added under the joint program to conduct demonstrations by delaying the start of product development by several years. Some of this added time—up to a year—will be needed to develop and deliver the new prototypes. As shown in figure 7, delaying the beginning of product development could reduce technical risks since DOD would have more time to test prototypes.

**Figure 7: Effect of Delayed Product Development Start on Program Risk**



Source: GAO analysis.

However, these delays may postpone initial operational capability beyond what DOD and the Congress originally anticipated, which was at the end of the decade. But recognizing this upfront to put the program on a sounder footing may be preferable to proposing a higher risk approach—like the 2002 plan—that is more susceptible to unplanned delays.

Drawing on the experience of the UCAV to date as well as other programs, DOD will face challenges in keeping the requirements for the new joint design balanced with available resources. One challenge relates to requirements. As mentioned above, more demands could be made of the air vehicle to meet the needs of both the Air Force and the Navy. Prior to the new joint approach, the Navy’s top mission for the UCAV has been conducting intelligence, surveillance, and reconnaissance. When considering the Air Force’s missions of reactive and preemptive SEAD and electronic attack, it is foreseeable that the program will face pressures to

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meet multiple missions. One approach to meeting this challenge is to delay the start of product development until resources—such as technology maturity—are available to meet all requirements. This would delay the program significantly and could raise funding issues. Alternatively, adhering to an evolutionary acquisition approach and developing the different mission capabilities in sequence could meet the challenge, so that the initial capability can be fielded sooner.

Another challenge relates to funding. Past and present programs have been susceptible to such funding issues. Moreover, other programs that dwarf the UCAV program—such as the F-22 and the Joint Strike Fighter—will be competing for investment funds at the same time.

We have found in earlier work<sup>8</sup> that although the Office of the Secretary of Defense provides some funding for advanced technology development efforts, the military services and defense agencies are ultimately responsible for financing the acquisition and support of equipment or items that result from the efforts. At times, however, the military services have not wanted to fund the transition process. This action either slowed down the acquisition process or resulted in no additional procurements. Specifically, military services have not wanted to fund technologies focusing on meeting joint requirements because those technologies do not directly affect their individual missions, and there are specific projects that they would prefer to fund. At the same time, Office of the Secretary of Defense officials told us that they lack a mechanism for ensuring that decisions on whether to acquire items with proven military utility are made at the joint level, and not merely by the gaining organizations, and that these acquisitions receive the proper priority.

The UCAV has already experienced some funding challenges. Recently, during preparations for the fiscal year 2004 budget cycle, the Air Force budget proposal eliminated all UCAV funding beyond that needed to finish work on two prototypes already on contract. The Air Force based this action on its belief that the X-45B UCAV was too small for the role the Air Force believed was most needed.

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<sup>8</sup> U.S. General Accounting Office, *DEFENSE ACQUISITIONS: Factors Affecting Outcomes of Advanced Concept Technology Demonstrations*, GAO-03-52 (Washington, D.C.: Dec. 2, 2002)

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To keep the UCAV program on track, the Office of the Secretary of Defense stepped in to resolve requirements and funding challenges and maintained a strong oversight over it. While the Office of the Secretary of Defense increased the challenge by accelerating the delivery date for the first UCAVs, it allowed the Air Force to defer the reactive SEAD requirement and fended off more radical changes to the UCAV's missions. In addition, the Office of the Secretary of Defense has taken the lead in brokering the agreement on the joint program proposal, adding development time to the proposal and working out a joint effort that could result in a single design for the Air Force and Navy. Sustaining the role played by the Office of the Secretary of Defense is likely to be important to meeting future challenges the UCAV may face.

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## Conclusion

UCAVs offer a potential for DOD to carry out dangerous missions without putting lives at stake and to find cost-effective ways of replacing DOD's aging tactical aircraft fleet. However, up until recently, pre-acquisition decisions had collectively increased requirements and reduced resources, putting the program in a riskier position to succeed. The decision to create a joint program could make for a better program if the gap between resources and requirements can be closed. The joint program faces a challenge in managing the demands of multimission requirements with the desire to field an initial capability in a reasonable time. Accepting increased requirements and accelerating fielding at the same time, as was previously done, will hinder the ability of the joint UCAV program to succeed. The program also faces the challenge of sustaining funding support from both services at a time when it is competing against other large aircraft investments. Regardless of which direction the new program takes, the role played by the Office of the Secretary of Defense will continue to be instrumental in helping to negotiate requirements, to assure the right resources are provided, and to make further difficult tradeoff decisions throughout the program.

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## Recommendations for Executive Action

We recommend the Secretary of Defense develop an acquisition approach for the joint UCAV program that enables requirements and resources to be balanced at the start of product development. This approach should provide mechanisms for brokering the demands of multiple missions, for ensuring that the product developer maintains a voice in assessing the resource implications of requirements, and for preserving the integrity of evolutionary acquisition. Reinstating the use of technology readiness levels may be very valuable in facilitating necessary tradeoffs.

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We also recommend that the Secretary formalize the management role performed by his office and the attendant authority to perform that role; ensure that the services are fully involved in the process; and work to develop an efficient approach to transitioning the UCAV from DOD's technology development environment to the services' acquisition environment so the needs of the war fighter can be met more quickly.

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## Agency Comments and Our Evaluation

DOD provided us with written comments on a draft of this report. The comments appear in appendix I. DOD provided separate technical comments, which we have incorporated as appropriate.

DOD concurred with our recommendation that the Secretary of Defense develop an acquisition approach for the joint UCAV program that enables requirements and resources to be balanced at the start of product development. It has directed the formation of a Joint Systems Management Office to define near-term requirements and to conduct robust operational assessments.

DOD partially concurred with our recommendation that the Secretary formalize a management role performed by his office and the attendant authority to perform that role; ensure that the services are fully involved in the process; and work to develop an efficient services' acquisition environment so the needs of the war fighter can be met more quickly. DOD noted that the Secretary is organizing the management function as he deems suitable. DOD did state that the department's UAV Planning Task Force would continue to provide oversight over all DOD UCAV program activities. We believe this is important because it was this organization that was instrumental in refocusing the DOD UCAV effort into a joint program that we believe will significantly improve the probability of successfully fielding UCAVs.

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## Scope and Methodology

To achieve our objectives we examined Air Force UCAV program solicitations and agreements, the demonstration master plan, trade studies, technology demonstration plans and results, status of critical technologies, plans to further enhance maturity of critical technologies, and plans to move UCAV to the Air Force for product development. We interviewed DARPA and Air Force program managers and technical support officials at DARPA program offices in Arlington, Virginia, and the Air Force's Research Lab and Aeronautical Systems Center at Wright Patterson Air Force Base, Dayton, Ohio, to document current development efforts and the maturity status of critical technologies and other attributes.



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To determine options that may be available to UCAV program managers in making changes to requirements or resources, we examined the program's risk assessments of its 15 technologies, processes, and system attributes to identify risk associated with beginning product development at different points in time. We interviewed Air Force Air Combat Command officials at Langley Air Force Base, Virginia, concerning UCAV requirements, and air staff officials in Arlington, Virginia, concerning program objectives and resources. We also interviewed a number of officials from the Office of Secretary of Defense having responsibility for UCAV oversight and funding.

We conducted our work from February 2002 through May 2003 in accordance with generally accepted government auditing standards.

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We are sending copies of this report to the Secretary of Defense, the Secretaries of the Air Force and Navy, the Director of the Office of Management and Budget and other congressional defense committees. We will also provide copies to others on request. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

Please contact me at (202) 512-2811 if you or your staff has any questions concerning this report. Key contributors to this report were Mike Sullivan, Jerry Clark, Matt Lea, Kris Keener, Travis Masters, Cristina Chaplain, Lily Chin, Bob Swierczek, and Maria-Alaina Rambus.



Paul Francis  
Director, Acquisition and Sourcing Management

# Appendix I: Comments from the Department of Defense



ACQUISITION,  
TECHNOLOGY  
AND LOGISTICS

## OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3000

June 23, 2003

Mr. Paul Francis  
Director, Acquisition and Sourcing Management  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Francis:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, GAO-03-598, "DEFENSE ACQUISITION: Matching Product Requirements with Resources Key to the Unmanned Combat Air Vehicle Program's Success" dated May 19, 2003 (GAO Code 120125/820003).

The DoD reviewed the draft report and partially concurs with the report's recommendations. Technical changes for clarification and accuracy have been provided separately.

The Department appreciates the opportunity to comment on the draft report. For further questions concerning this report, please contact Lt Col Bill Bridges, UAV Planning Task Force, 703-695-8817.

Sincerely,

Glenn F. Lamartin  
Director  
Defense Systems

Enclosure



GAO DRAFT REPORT - DATED MAY 19, 2003  
GAO CODE 120125/GAO-03-598

“DEFENSE ACQUISITIONS: Matching Product Requirements with Resources  
Key to the Unmanned Combat Aerial Vehicle Program’s Success”

DEPARTMENT OF DEFENSE COMMENTS  
TO THE RECOMMENDATIONS

**RECOMMENDATION 1:** The GAO recommended that the Secretary of Defense develop an acquisition approach for the joint UCAV program that enables requirements and resources to be balanced at the start of product development. This approach should provide mechanisms for brokering the demands of multiple missions, for ensuring that the product developer maintains a voice in assessing the resource implications of requirements, and for preserving the integrity of evolutionary acquisition. Reinstating the use of technology readiness levels may be very valuable in facilitating necessary tradeoffs. (p. 15/GAO Draft Report)

**DOD RESPONSE:** The Department concurs with this recommendation and we are developing an acquisition approach to balance resources with evolving requirements throughout the program. The Department has directed the Air Force, Navy, and DARPA to form a Joint Systems Management Office (JSMO). The JSMO will help define near-term Service requirements for a highly survivable unmanned combat system by planning and executing a series of robust operational assessments. Once these initial requirements are identified the mechanism for matching resources will occur through the Planning, Programming, and Budgeting System.

**RECOMMENDATION 2:** The GAO recommended that the Secretary formalize the management role performed by his office and the attendant authority to perform that role; ensure that the Services are fully involved in the process; and work to develop an efficient approach to transitioning the UCAV from DoD’s technology development environment to the Services’ acquisition environment so the needs of the war fighter can be met more quickly. (p. 15/GAO Draft Report)

**DOD RESPONSE:**

The Department partially concurs with this recommendation to formalize a management role. The Secretary is organizing the management function as he deems suitable. The mechanism for transitioning UCAV specific capability from technology development to a Milestone B decision (the start of “product development”) is through establishment of the JSMO. The JSMO goal is to assess UCAV capability to meet warfighter needs through a series of operational assessments, and plan for a normal transition to “acquisition” if successful. Although less structured in the early stages, this JSMO will be adaptive and foster multi-organizational partnering. The Department’s UAV Planning Task Force is actively engaged in the development of the JSMO and will continue to provide oversight over all DoD UCAV program activities.

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