The X-45, which began as a simple, short-range UCAV, is now starting to look like an unmanned bomber.

HEAVYWEIGHT

By John A. Tirpak, Executive Editor

THE Air Force has been adding missions, range, and new capabilities to the list of requirements for its Unmanned Combat Air Vehicle, increasing the size of the operational version by one-third, while increasing its sophistication, complexity, and cost. The project's expanded scope has

NASA photo by Jim Ross

CONTENDER

The X-45A over Edwards AFB, Calif., on its May 22 first flight.

altered the concept of operations for its combat use and raised questions about whether it will continue to be the cheap drone the service originally had in mind.

The changes also potentially pit the aircraft against the F-35 Joint Strike Fighter for a sizable share of USAF's future strike force structure.

"It is all a balance," said Gen. John P. Jumper, USAF Chief of Staff. "We are trying to find where those curves intersect between affordability, range, and payload and also to get the concept of operations right."

The UCAV is an Advanced Concept Technology Demonstration, undertaken jointly by the Air Force

NASA photo by Carla Thomas

The UCAV flares for landing, after a 14-minute first flight. Handling qualities were judged to be good, and the no-tail airplane was stable throughout the flight. Testing will focus on mission, rather than violent maneuvering.

and Defense Advanced Research Projects Agency. An ACTD is a fast-track development program intended to explore a new capability and rapidly yield a product that could actually be used in the field. The Predator and Global Hawk Unmanned Aerial Vehicles followed this pattern. Both were used in combat while still in test.

Defense Secretary Donald H. Rumsfeld has identified unmanned vehicles as one of the key types of systems in his campaign to transform the American military for wars of the future.

The success of both Predator and Global Hawk in wartime operations has given the Air Force confidence that the UCAV will be able to make good on its promise of being a highly stealthy and reusable autonomous aircraft, able to deliver precision weapons against the very toughest targets, yet cheap enough that the service could bear to lose some in combat.

As recently as last fall, the Air Force concept of operations called for the UCAV to be a relatively short-ranged aircraft. It would be kept in storage until needed, then shipped in "smart" containers to forward areas, there to be unboxed, assembled, and then flown against enemy air defenses. (See "Send in the UCAVs," August 2001, p. 58.)

Unmanned Bomber

Now, however, the UCAV is seen more as an unmanned bomber—larger, with expanded range, capacity for aerial refueling, and a weapons bay almost the same shape and size as that of the F-35. It could deploy from US bases, proceed directly to its targets, and recover at a forward location to quickly rearm and refuel for another mission.

The original concept said "we are going to put these things in cases and put them on C-17s or C-5s and deploy them," Jumper explained. "But then, when you get to the other end, you have to have teams of people that assemble them [and] test fly them before you can load them and fight with them. That just took the 'rapid' out of airpower."

To quicken the pace at which UCAVs can get into the fight, the Air Force is adding aerial refueling capability and additional internal tanks, which will increase the size of the UCAV, Jumper acknowledged. The two provisions will allow flexibility to deploy with or without tanker support, depending on the theater involved, he said.

Adding size and complexity adds cost, however, and Jumper allowed that the current vision of the UCAV is "not a razor blade anymore" and has the potential to become "quite expensive."

"So, it is a balance," Jumper summed up. "Do we have it right? I hope so, but that is what development and ACTDs are all about, and that is what we want to explore. As this technology demonstration goes on, we hope that it will give us the answers to those very questions."

The Air Force–DARPA project right now is focused on the X-45A, a Y–shaped experimental craft that will prove out flying qualities and flight-control software. First flight of the craft, designed and built by Boeing, took place in late May, and flight tests with the two initial aircraft are expected to continue over the next two years or so.

The X-45B aircraft will be larger, with a two-thirds increase in area and a one-third increase in weight. It will have the ability to carry weapons and demonstrate various kinds of attacks—singly and in groups—as well as conduct operations in concert with manned aircraft.

Fighter-Size

The new version will be about the same size as an F-16, with an empty weight of 10,000 pounds and a gross weight of about 19,000 pounds. It will have a payload of 3,600 pounds.

The first operational version—referred to now as simply the Block 10 UCAV—would be dedicated to attacking heavily defended surface-to-air targets. Officials refer to this as "pre-emptive" Suppression of Enemy Air Defenses. The Block 10 will have the capacity to carry 12 250-pound Small Diameter Bombs, the same load envisioned for the F-35. It will also be able to carry extra fuel tanks both internally—in the weapons bay—and on external plumbed hardpoints. It will also be stealthier than the X-45A.

The Block 20 model will add reactive–SEAD capabilities. As it orbits the battlefield, it will be able to detect new air defense threats and autonomously attack them.

The Block 30 model will go a step further, able to carry high-powered microwaves or other kinds of directed-energy weapons with which it could destroy enemy radar sets, sensors, and battlefield electronics.

None of the versions will be "flown" by a remote pilot. There will be a supervising operator who will work at a remote, specially configured workstation, but that operator probably won't be a pilot and won't have a joystick with which to control the aircraft.

The operator will initiate missions,

monitor the health of UCAVs—probably three to five vehicles at once—en route to target, and give consent for weapons release, but the vehicle itself will do everything else, from takeoff to landing, target identification, and attack.

In keeping with Rumsfeld's vision, the Fiscal 2003 budget accelerated the UCAV program by about two years—aiming to field the first 14 Block 10s in 2008 with the goal of acquiring as many as 60 Block 10s in total.

George K. Muellner, president of Boeing's Phantom Works advanced development unit, which is building the X-45, said he's pleased to see the user—in this case, Air Combat Command—involved so early in the process of developing a new system.

"One of the problems you always have early on with programs is that the users don't really pay as much attention to them as you would like," because in-service dates are "a long ways off," and the users are more occupied with current operations, said Muellner, a retired three-star USAF general with long experience in acquisition and development projects.

"But as UCAVs started to become more of a reality, then they started to come in and say, 'Jeez, if we had a little bit more here, a little bit more there.' So, the positive aspect is, you have a lot more user involvement. The negative aspect is ... if you're not careful, you put yourself on the slippery slope of producing an expensive platform."

Boeing photo

The second X-45A is readied for flight. UCAVs will be developed and fielded in a "spiral" fashion; refinements will be added as lessons are learned from early deployment and combat use. Block 30 will have energy weapons.

Muellner described this tendency as "mission creep" and told a symposium of the American Institute of Aeronautics and Astronautics in April that it "threatens the affordability" of UCAVs.

Muellner explained that mission creep "is generally productive; it adds ... warfighting capability." He went on to say, "If you don't do it in a proper manner, it will add ... development time, and you want this transformational capability out there as soon as possible."

Muellner cheered the government's approach to UCAVs. That approach, called "spiral development," adds new features incrementally, building capabilities into the system as real-world experience is acquired.

"My personal view is, the path that's been executed with the Predator and the Global Hawk is really the way we ought to be doing things. ... We fielded what we had, we learned a lot, we changed it, we upgraded it, improved it."

Don't Wait for Perfection

What's to be avoided, Muellner said, is "to sit around and wait until you know what the perfect solution is. ... If you keep changing requirements, you're never going to get the vehicle."

The original targets were for the UCAV to cost half as much to buy and only 25 percent as much to operate as an F-16 over its service life. Those targets have been thrown into flux as the program has expanded.

However, Muellner said that the increase of a third in size will not necessarily correspond to a one-third increase in cost. He noted that weight and cost have traditionally been "directly related," but that's no longer the case.

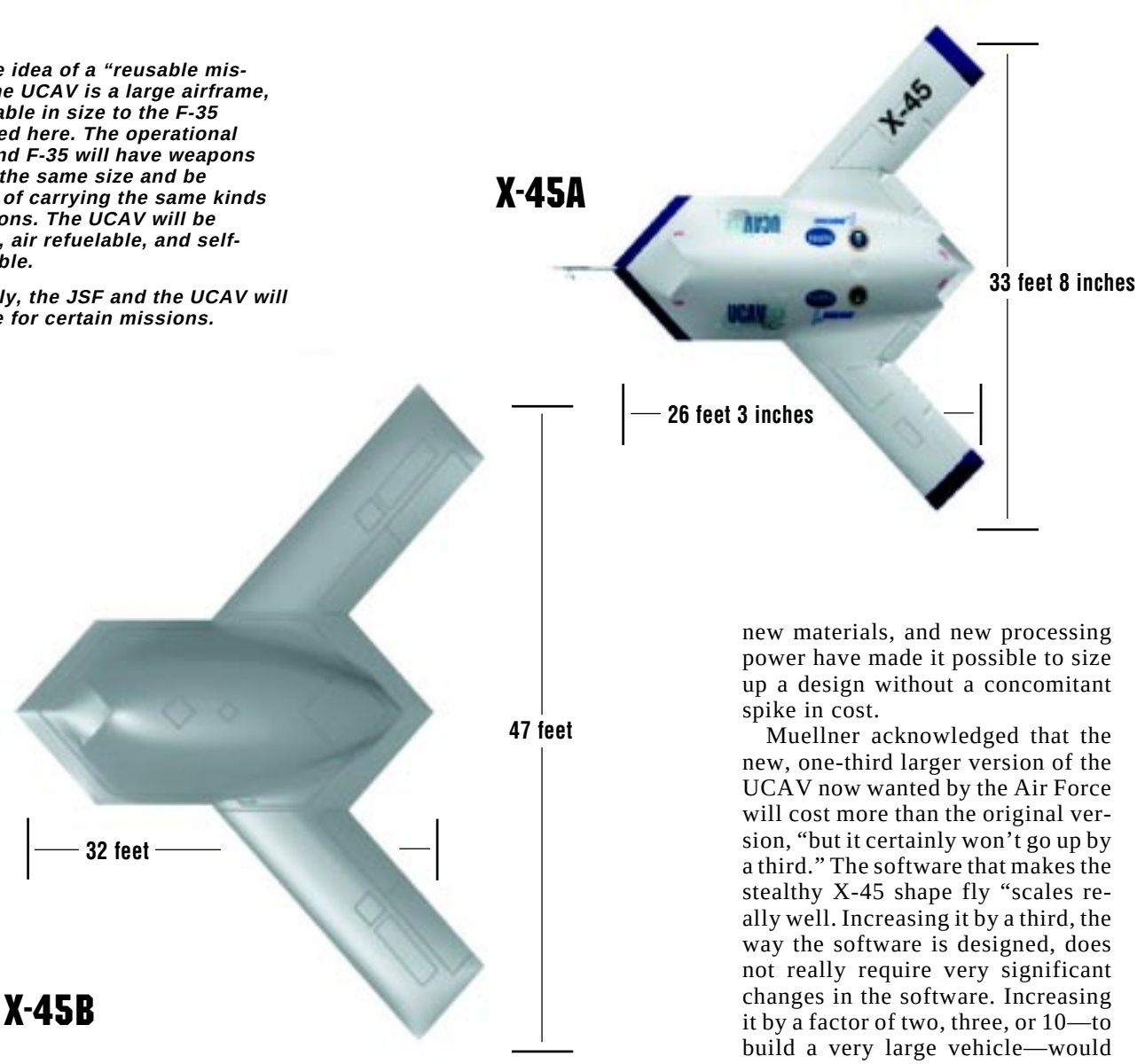
"What we and Lockheed Martin demonstrated on JSF is that we've come a long way in decoupling those," he explained. New, lean design and manufacturing techniques,

NASA photo

Gear was not retracted on the first flight, which is typical for a prototype. In combat, UCAVs may fly formation with manned aircraft, peeling off to strike pop-up air defense threats, or on their own, flying pre-emptive SEAD.

Lose the idea of a "reusable missile." The UCAV is a large airframe, comparable in size to the F-35 illustrated here. The operational UCAV and F-35 will have weapons bays of the same size and be capable of carrying the same kinds of weapons. The UCAV will be stealthy, air refuelable, and self-deployable.

Inevitably, the JSF and the UCAV will compete for certain missions.



new materials, and new processing power have made it possible to size up a design without a concomitant spike in cost.

Muellner acknowledged that the new, one-third larger version of the UCAV now wanted by the Air Force will cost more than the original version, "but it certainly won't go up by a third." The software that makes the stealthy X-45 shape fly "scales really well. Increasing it by a third, the way the software is designed, does not really require very significant changes in the software. Increasing it by a factor of two, three, or 10—to build a very large vehicle—would not require a great deal [of software change] either."

An ACC official said he's not concerned about the possibility of mission creep destroying the affordability of the UCAV.

"I want them to do these excursions," he said. "This is the time for them to think about what's possible, instead of later, when it's either too late or too expensive to add these things, and it might not cost too much more if you design it in at the outset."

Air Force Secretary James G. Roche has suggested that a very large UCAV—bomber-size—might be a good idea, since bombers typically go after fixed targets, which can easily be programmed into a UCAV's flight plan. Moreover, bombers in Afghanistan orbited the battlefield, waiting to be called on to precisely

deliver ordnance. Such a long, dull mission—punctuated by an easily calculated attack—might be well-suited to an air refuelable, large-scale unmanned vehicle, Roche suggested.

Compelling Logic

Muellner acknowledged that Roche has brought up the idea of the bomber UCAV in a number of venues, as a possible bridge from the current aging fleet of bombers to a future system.

"And ... there are other folks like Secretary Roche, who say maybe this is our next-generation long-range strike airplane until we get to hypersonics or whatever. ... To be honest with you, I find that logic to be pretty compelling," Muellner said.

He said he's convinced that Boeing can begin producing Block 10 UCAVs in 2006. The only real challenge to doing so is completing the software for the control laws, he said. The Block 20 timetable, though, depends on success in another DARPA program, called the AT3 project, which he described as an "advanced technology emitter location program."

The AT3 would replicate what human crews used to do on the F-4G "Wild Weasel" SEAD aircraft: identify the type of an enemy air defense system and precisely locate its position for attack. It would do so with far more precision, however.

"It's an ideal solution for the UCAV," Muellner said. With multiple UCAVs in the threat area, they will be able to triangulate the position of an enemy emitter, such as a search or tracking radar, decide among themselves which is best positioned to attack it, and swiftly swoop down for the kill.

Because the UCAV will be so stealthy, "you can now go attack that emitter with a Small Diameter Bomb, instead of just shooting a HARM" at it. High-speed Anti-Radiation Missiles tend simply to discourage enemy radar operators from turning on their equipment; they typically don't score a total destruction of the enemy radar.

If the AT3 is not available in time for the Block 20, more conventional threat identification and location gear will be fitted, Muellner said.

While the Predator and Global Hawk have served as models for the UCAV project, they also pointed up things to avoid, said USAF's X-45 program director, Col. Michael Leahy.

Predator's project managers didn't originally expect to send their UAV demonstrator into combat, and the program was not initially set up with the spares and support capabilities needed for operational fielding, Leahy said.

"Predator is the anti-analogy," he said. "We will be supportable and maintainable in the field ... from the beginning. ... We have learned from Predator and Global Hawk."

Technology Pioneer

Like those aircraft, the UCAV was also envisioned more as a technology pioneer than as a prototype for a full-up weapon system and has apparently slid past the stage where there will be competition for the program.

Typically, major systems are competed at the concept definition stage, where two production-worthy aircraft types are tested and evaluated and the best one selected for development. Leahy said Boeing could conceivably face competition from another company. Lockheed Martin

NASA photo by Jim Ross

Although there is great promise for the attack mission, UCAVs are not viewed as a replacement for the air-to-air combat role. For that, bandwidth and processing demands still favor having an actual fighter pilot on board.

US Navy photo by Jennifer A. Smith

Global Hawk was considered for a UCAV role, but now will not be armed. The Bush Administration has identified unmanned vehicles as one of the "transformational" technologies of this decade, for all the military services.

Erik Simonsen illustration for Boeing

In this artist's view, a pair of Block 10 UCAVs drop JDAMs. A remote operator will approve weapons release. Otherwise, UCAVs fly and fight on their own. If the design proves out, this scene could become reality in just six years.

might offer a UCAV concept. Northrop Grumman is already working with DARPA and the Navy on its Pegasus UCAV, which is of comparable size and capability.

However, "the Air Force has to decide the acquisition strategy at Spiral 2," now slated for next year, said Leahy.

"We could reopen competition" at that point, he said, "but there is no firm commitment to do that. It doesn't make much sense to have a competition for 14 vehicles."

He added that the whole purpose of an ACTD "is to learn. After we learn, we will decide how many ... and then decide the force structure. ... At this point, we think it's in the best interest of the Air Force to continue" with Boeing.

The X-45 will progress rapidly through a series of operational evaluations, the results of which will feed back into the software and design of the vehicle "as we learn things about what the X-45 can and cannot do" that might not have been apparent before, Leahy said.

The Air Force's new term for spiral development is "effects-based development," Leahy said. Jumper coined the term to better define what the service is trying to do: obtain specific effects, regardless of the platform, system, or weapon that achieves them. In the case of the X-45, Leahy noted, it will be acceptable in early iterations to achieve "the 60-percent ... or 80-percent solution," especially if it provides a new capability that directly speeds the prosecution of the war.

The X-45's graduation exercise—now expected in about 2004—will involve multiple vehicles, working with manned aircraft in a Red Flag–type scenario, Leahy explained. The UCAV will have to demonstrate its ability to work alongside manned aircraft, serving as an escort SEAD platform.

Because they will be on an air tasking order as well as the airspace coordination order, UCAVs will fly at prescribed altitudes and in known geographic areas. However, they will also have interactive capabilities, said Muellner, and be smart enough to get out of the way of a manned airplane. Other options for deconfliction of UCAVs with manned aircraft might include adding terrain collision avoidance systems.

"We're assuming we're going to have to build a more flexible design," Muellner said, that will go beyond simply observing restricted air corridors and altitudes. UCAVs will be capable of flying up to 45,000 feet, and USAF wants it able to be compliant with US and international air traffic control conventions.

Smart Containers

Leahy said the Air Force has not abandoned the idea of the smart-container system, in which UCAVs could be stored for 10 years or more in a box that monitors its health and can be used to move it by cargo airplane. Rather than six per C-17, however, four or fewer of the new, larger UCAV containers will fit.

Muellner said USAF was also interested in the self-deployment feature because "they want the lift for other things."

The UCAV development program is "fully funded," Leahy said. Next year, the Air Force will begin assuming more of the responsibility for the development of the operational version. The demonstration effort will be completed with three X-45B aircraft, Leahy said, and 14 is now seen as "a reasonable number" for a limited initial operational capability with the Block 10. Notionally, a follow-on order for 16 aircraft is seen beyond that. At 30 vehicles, this would make UCAVs "about one-third of [USAF's] deep-strike force," he said. This would match the prediction by Sen. John Warner (R–Va.) who said in Fiscal 2001 budget language that UCAVs would, within 10 years, comprise a third of the deep strike force.

It could go considerably higher than that.

"UCAV is starting to be talked about as a real significant portion of the force," said a senior Air Combat Command official.

"The range is about the same as the JSF [about 650 miles combat radius]. The payload is identical. So then, for certain missions, these become interchangeable aircraft. And UCAV will be a heck of a lot cheaper. How many we buy and for what purposes will be an important element of how we plan our post–2010 force structure."

The official added that Boeing's involvement with the UCAV—and the possibility of its being a large-scale procurement project—cooled the Pentagon on any effort to insist on Lockheed Martin giving a share of its JSF work to Boeing as an industrial base issue.

"There will be plenty of work to go around," he said. "I really think you may see these two programs competing, so there's your work share."

Jumper cautioned against trading JSFs off against UCAVs for now.

"That is an answer that will come after the thing has proved itself," Jumper asserted. "It is much too early to be going there, I think." ■