The Pentagon is putting up $2.5 billion in earnest money to develop UAVs. The Air Force is dead serious about employing them—but in addition to, not instead of, manned aircraft.

On the Horizon: Unmanned Aerial Vehicles

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DURING the Vietnam War, an Air Force reconnaissance drone lost power, came down in the Gulf of Tonkin, and stayed afloat. A helicopter was sent out to retrieve the drone and the pictures it had taken of enemy targets. The chopper also failed, plopped into the drink, and began to sink.

Three crewmen clambered out of the foundering helicopter and clung to the bobbing drone until they were picked up by a US Navy ship. After they were brought aboard, a sailor who had witnessed their rescue asked them: "How did all you guys get into that little airplane in the first place?"

This story may be apocryphal, but it makes the point—people tend to think of aircraft as naturally containing humans.

Not necessarily so. Unmanned aircraft have been around a long time and have come in handy in wars, especially in the Middle East and Southeast Asia. Only now, however, are they beginning to emerge as first-team players at many positions in US military forces.

Under the guidance of the Defense Department's recently organized joint program office for "unmanned aerial vehicles," the Army, Air Force, Navy, and Marine Corps are coordinating plans for families of UAVs for a wide variety of missions. The office is headed by Rear Adm. William C. Bowes, who is also in charge of the Navy-Air Force joint cruise missile program.

The blueprint for all this is the "Department of Defense Joint UAV Program Master Plan" that the Pentagon submitted to Congress earlier this year. It was drafted by the services in response to sharp congressional criticism of their individual management of unmanned aircraft development programs.

A prime case in point was the Army's Aquila remotely piloted drone for reconnaissance, target acquisition, and target designation with lasers. Aquila was canceled, the victim of requirements-creep and cost overruns, but proved useful in teaching the UAV development community many valuable lessons about what not to do. Aquila drones will also be used for testing other UAV concepts.

Congress became exasperated with the Aquila program and, more

Unmanned aerial vehicles come in many configurations and can be flown on all sorts of missions, as set forth in the Pentagon's new "master plan" for UAVs. Shown here are the bellwether Northrop BQM-74C UAV, right, and a newer sweptwing variant.

broadly, with the tendency of each of the services to go it alone in developing—or in choosing *not* to develop—UAVs. The lawmakers decried such separatism as uneconomical and militarily unwise and demanded, with some encouragement from the Office of the Secretary of Defense, that the services unify their management of UAV programs.

The concerted effort that came of this is clearly not a passing fancy at the Pentagon, where $2.3 billion has been earmarked for the development of UAVs through Fiscal Year 1994.

Many major defense contractors are involved in the UAV program. It has also attracted a host of smaller companies, lesser known but with strong backgrounds in UAVs and attendant systems, such as data links and ground stations.

Unmanned Aerial Recon

The first operational UAV expected to ensue from the master plan is the Unmanned Air Reconnaissance System (UARS) being developed jointly by the Air Force and the Navy for tactical reconnaissance. Control Data Corp. recently won the Air Force contract to build the Advanced Tactical Air Reconnaissance System (ATARS) electronics suite for the biservice UARS program and for the tactical reconnaissance aircraft that will be chosen at some point to replace USAF's RF-4Cs.

The program to develop unmanned aircraft to carry ATARS is being managed by the Navy for both services and has captured the attention of such companies as Northrop, Canadair, Teledyne Ryan, and a Martin Marietta/Beech team. The Navy is expected to pick a winner by the end of this year.

As the master plan puts it: "UAV systems provide a technical alternative to manned aircraft and satellite systems." As the Air Force sees it, this is all well and good—but don't get carried away.

USAF acknowledges the increasing need for unmanned aircraft on such missions as targeting, reconnaissance, and suppressing the increasingly dense and ferocious air defense systems that its manned fighters and bombers would come up against in modern combat.

Armed with a Shrike antiradiation missile under its right wing and a bomb under its left, this Teledyne Ryan Aeronautical Model 234 remotely piloted vehicle (RPV) once served as an air-to-ground weapons launcher. Nowadays, such pilotless planes are full-blown weapon systems in themselves, not merely launchers. Whatever their missions, all such craft have come to be called UAVs, for "unmanned aerial vehicles." Many are capable of autonomous flight.

Even so, the service's sense of urgency in developing UAVs remains suspect in some circles where it is charged with having an ingrained, institutional bias against anything that threatens to put pilots out of work.

Air Force leaders deny this. They note that USAF has used unmanned planes for many years, that it joined with the Navy in the UARS program long before there ever was a UAV master plan, and that it is earnestly developing radar-homing drones—in its Tacit Rainbow and Seek Spinner programs—for defense-suppression missions.

Those drones, the ones designed to kill, are not covered by the UAV master plan and do not come under the joint program office. The plan and the office deal only with "nonlethal UAVs," the kinds designed to do reconnaissance, surveillance, targeting, and electronic warfare work, for example.

The Air Force says it has nothing against UAVs per se, but does not believe in buying them before their time. That time has come.

Almost three years ago, an Air Force general officer told Congress: "Air Force involvement in nonlethal unmanned vehicles is not new, but our interest in them has increased significantly."

Why? "We now believe," he said, "that technology can support an effective and affordable unmanned system to meet some of our more challenging fixed-target reconnaissance requirements."

The speaker on that occasion was Maj. Gen. John M. Loh, then the Director of Operational Requirements in USAF's acquisition and R&D establishment at the Pentagon. Now Lieutenant General Loh, he took command of Air Force Systems Command's Aeronautical Systems Division last August 1 and will have a lot to say about USAF's plans for and development of UAVs.

Drones Through History

Unmanned aircraft go back to World War I, when the "Bug," an unpiloted biplane stuffed with high explosives that was intended to fly off and crash somewhere near its target, was tested but never sent forth to do the real thing.

In World War II, the V-1 weapons

were quasi-drones. There were others, too, including the B-24 bomber that exploded and killed Navy Lt. Joseph P. Kennedy, Jr. He was to have bailed out after setting the bomber on a remotely controlled course to a high-value target in Germany, but something went wrong. The US also used some World War II B-29s on remotely controlled bomb runs in the Pacific theater.

After World War II, drones took to the air as target aircraft, nothing fancy. But they soon evolved into more sophisticated variants that could be electronically flown from afar on increasingly intricate surveillance and reconnaissance missions—which is why they came to be called RPVs (for remotely piloted vehicles).

Even before the Soviets shot down the US manned U-2 spy plane in May 1960, Ryan Aeronautical (now Teledyne Ryan Aeronautical) and Boeing were devising reconnaissance RPVs for the Air Force.

These birds came along smartly and soon constituted a growing family. USAF flew about 3,400 RPV missions over Southeast Asia through eight years of the Vietnam War. The Ryan RPVs in widespread use in that period evolved into more than twenty different configurations capable of carrying increasingly versatile and sophisticated payloads.

In the main, the RPVs of the Vietnam War were used for reconnaissance, electronic intelligence, and psychological warfare. They were effective, but there were problems of navigation, recovery, and mission reconstruction (*i.e.*, figuring out ex post facto where the RPVs had been when they did certain things) and their operations and support costs were awfully steep.

So USAF backed away from RPVs after the war. Defense budgets were shrinking and pilots were being RIFed. It was no time to overdo drones. Besides, the Air Force preferred to hold off on them until advances in electronics could solve some of their problems.

Already evident in the Air Force and Navy programs of the early 1970s to develop cruise missiles, those advances would make it possible to preprogram the flight paths, speeds, electro-optical enterprises, and other workings of the unmanned aircraft into their on-board computers and then to turn them loose, rid of remote controls, to do their missions on their own.

A Teledyne Ryan Model 324 Scarab UAV takes to the air from its ground launcher in the Mojave Desert. Egypt contracted with the US company to develop this remotely piloted jet aircraft. Twenty feet long with a twelve-foot wingspan, it can fly as fast as Mach 0.8 and deploys a parachute and an air bag to land.

This autonomy of flight in some modern drones is why the catchall designation "UAV" best describes all of them, including those that remain remotely controlled. Definitions are blurring or doubling up all over the place. For instance, the Tacit Rainbow unmanned jet aircraft being developed by Northrop to loiter on high and then swoop down on enemy radars could be called a UAV, a cruise missile, or even a standoff weapon. But it is most definitely not an RPV.

Israeli Use of UAVs

The Israelis made excellent use of UAVs (the RPV sorts) in combat against the Egyptians and Syrians in 1973 and against the Syrians in 1982. They deployed them as decoys on reconnaissance, targeting, and electronic warfare (EW) missions to draw the fire of surface-to-air missiles, fingerprint the radars of those SAMs, and jam and destroy them.

In the beginning, UAVs used by the Israelis were made in the US. But the great wartime achievements of these unpiloted aircraft spurred the Israelis to begin building their own and to move ahead of the US in the UAV operational arena. The US Navy has had great success in the Persian Gulf with "Pioneer" UAVs. Pioneers were first produced in Israel and are now built by a US company, AAI, as well.

Pentagon officials give the Israelis all due credit for this good work on and with UAVs but are quick to point out that the mostly sunny Middle East is much more conducive to UAV operations—and much less demanding of UAV designs—than is the usually cloud-covered European continent.

What with one thing and another, however, General Loh told Congress, "We believe it is now time to take a serious look at unmanned reconnaissance vehicles for the Air Force inventory. Our rationale for this decision is simple: We believe technology can now provide us with reliable and affordable engines, structures, precision navigation systems, solid-state sensors, and recovery systems."

Given all this, the Air Force looks forward to having "an unmanned option against some of our more challenging reconnaissance targets," the General testified.

The Air Force has broadened its plans for UAVs well beyond the UARS reconnaissance planes, even though those UAVs remain supreme in such plans.

Maj. Ken Thurman, a UAV operations specialist on the Air Staff who also represents USAF in the UAV joint program office, calls his service's moves toward unmanned aircraft a "watershed development. In the past, we've always emphasized unmanned air vehicles during wars, but deemphasized them after wars. This is the first time that something is getting done on them while we're not at war."

The Air Staff asked all USAF major commands to report on the requirements that they have or may have for UAVs. The majcoms responded with gusto. All said they do not expect to have anywhere near enough manned airplanes to do all the missions for which they are responsible and that UAVs would be most welcome—especially for missions now being referred to in UAV circles as "the three 'D's—dangerous, dirty, and dull."

Respective examples are photorecon missions 200 miles or so into heavily defended enemy territory, flying in an NBC environment (one that has been contaminated by nuclear, biological, or chemical weapons), and loitering at high altitude for hours or days on end in a surveillance mode.

These missions and more are covered in the multiservice UAV master plan. Its categories of unmanned aircraft, requirements, and performance characteristics are:

- *Close-range systems* for surveillance, target-spotting, target acquisition, disruption, and deception. These UAVs would be remotely controlled or tethered to the ground—for example, at an air base, where they would be used to patrol the perimeter in the manner of sentries, to sniff the air for evidence of contamination, to assess post-attack damage to runways, or even to act as air defense radars in replacing or augmenting the tall-masted radars that are now deployed from trucks.

The UAV master plan foresees a maximum range of about thirty kilometers for these close-range aircraft and describes them as "intended to satisfy the requirements of lower-level tactical units and small ships" in "investigating local-area activities," adding: "UAV systems in this category could be fielded in large numbers and therefore must be low in cost."

One close-range UAV in the Air Force's cornucopia of conceptual designs for all such vehicles looks and acts like a flying saucer.

- *Short-range systems*, all remotely controlled, ranging 150 to 300 kilometers from home and having many of the same capabilities as their close-range cousins, plus more. They could be used for target designation as well as target-spotting and target acquisition, for relaying communications, and for detecting NBC contamination.

These systems, says the master plan, are to be "relatively low-speed [and] moderate in cost and complexity" and should be capable of fairly protracted surveillance "from low and medium altitudes."

The master plan's description of short-range UAVs points up how the Pentagon is trying to avoid ridiculous extremes of multiservice commonality in unmanned aircraft even while making such systems as standard as possible across the services. It says:

"The UAV systems in this category will have different airborne components to provide the range, endurance, payload capability, and survivability required for mission performance. However, the launch and recovery, mission planning, mission control, sensor ground processing and exploitation, data links, and data-relay capabilities are expected to be very similar—if not identical—for all."

- *Medium-range systems*. Slated for the Air Force, the Navy, and the Marine Corps, these UAVs will provide the "capability to conduct pre- and post-strike reconnaissance in support of strike operations by unmanned aircraft." Seen as "relatively low-cost complements to manned aircraft," the UAVs in this category will be "increasingly attractive" in view of "the rapidly increasing lethality of air defense systems" and because they "do not expose aircrews to the risk of loss or capture," says the Pentagon's plan for UAVs.

The Air Force-Navy UARS vehicles fall squarely into this prescribed category. The master plan projects that all such medium-range unmanned aircraft will have a maximum 700-kilometer radius of flight and the ability to "fly to, between, and from observation areas at high-subsonic speeds."

No Loitering

Unlike their high-altitude brethren, these medium-range UAVs would not loiter. They could be preprogrammed to fly their routes from checkpoint to checkpoint or to be remotely guided along those routes—depending on the ranges and complexities of their missions. And they could be launched from land or from manned aircraft.

The Air Force subscribes to all this. "We believe that the unmanned vehicle has overcome its technical limitations and that it's time to get on with . . . a UARS to complement our manned systems," General Loh told Congress.

He described the UARS planes as flying at "medium- to high-subsonic speeds, at low to medium altitudes," and as having a combat radius of "at least 300 nautical miles."

The UARS aircraft will embody essentially the same type of small turbofan jet engine that powers cruise missiles. Their electronics and optics will be married in sensors, signal processors, and data processors capable of swiftly and selectively capturing images of targets and sending them to ground-control stations in the form of digital data in what USAF calls "near real time."

The UARS navigation system will have to be extremely precise, in the manner of cruise missiles, and the aircraft will have to be able to operate around the clock and be recoverable.

All this is a tall order. As one officer in the tactical community puts it, "We'll have to wait and see. If one of those drones goes a little bit off course—if it doesn't do what it's supposed to do at any point along its flight path—the whole mission is shot, kaput. But we need them, and they're certainly worth a try."

Commonality and flexibility are

the catchwords in the Air Force-Navy UARS program. The unmanned aircraft being developed in that program will have the same sensors as the future tactical reconnaissance aircraft of both services, be they RF-4s, RF-16s, RF-18s, or whatever, and will be compatible with all Air Force and Navy tac recon ground and ship stations as well.

"We can no longer afford sensor packages unique to one platform that requires its own ground station," declares Maj. John Snider, a joint-requirements officer in USAF's advanced-programs acquisition division at the Pentagon. "In the master plan, we've cut out a lot of duplication in platforms, and we're trying to do the same thing with sensor packages and ground stations in the UARS program."

That program "gives us, for the first time, an unmanned vehicle that can talk to something besides the ground station that launched it" and also marks "the first time we've had an unmanned-manned crossover" in interoperability of systems, Major Snider notes.

• *"Endurance" systems.* These UAVs would have a range of about 300 kilometers over land or sea under remote control or preprogrammed guidance. They would be capable of loitering on high for up to thirty-six hours for reconnaissance, communications relay, target acquisition, weather observation, and NBC detection.

The master plan notes that the development of such systems will concentrate at first on making them capable of "wide-area surveillance using SIGINT [signals intelligence] and other sensors," says the UAV document. "Communications relay is a secondary but important capability, with EO sensors the next area of priority."

All four services are destined to deploy long-endurance UAV systems. Much work has already been done in bringing them about. The first of their kind is flying.

It is called Amber, the outgrowth of a program in which the Army, the Navy, and the Marine Corps teamed with the Defense Advanced Research Projects Agency (DARPA) to explore concepts for HALE (High-Altitude Long-Endurance) UAVs.

Amber unmanned aircraft have been wrung out at the Utah Test and Training Range at Hill AFB and have attained thirty-one hours of continuous flight at altitudes up to 27,300 feet. Their top flight duration is a world record.

DARPA Director Dr. Raymond S. Colladay claims that "this enhanced UAV capability" demonstrated by Amber aircraft "will add unprecedented flexibility to future military operations" and is only the start of something big.

Readying Amber

The Amber UAVs are being readied for deployment with the US fleet, maybe as soon as next year, and in Army areas outside Europe. But ideas for a second generation of such UAVs—already called Amber II—are being transformed into reality.

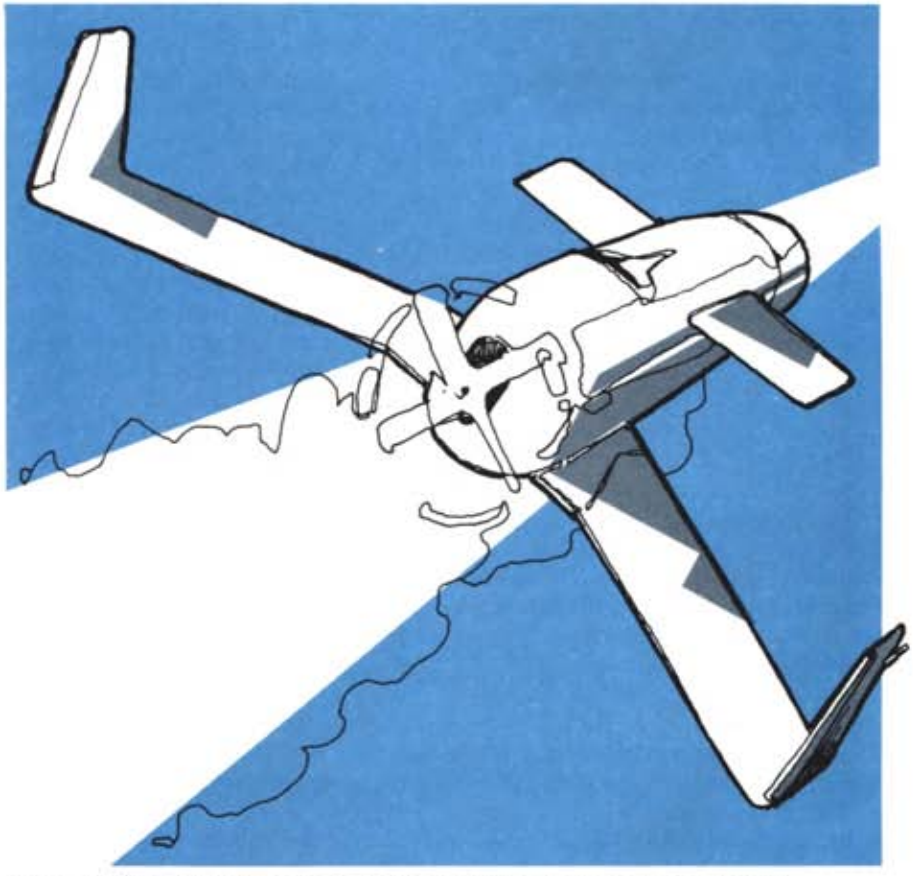
Amber II aircraft are expected to be better suited to the European theater because they will outfly their progenitors and be much more survivable. Meanwhile, the original Amber UAVs will serve as platforms on which to test MTI (moving target indicator) radar, communications relays, and SIGINT payloads being developed for deployment aboard unmanned aircraft in the years to come.

The UAV master plan mentions that Amber aircraft will be used in the testing of Skydancer, a classified SIGINT endeavor of the National Security Agency.

The Amber UAV program and the MTI radar program may well be paving the way for unmanned aircraft to succeed the Air Force's manned TR-1 and Joint STARS target-spotting airplanes in Europe some day—maybe sooner than anyone had thought possible.

The Air Force is keeping an ambivalent eye on this. It treasures its Joint STARS aircraft as the best things since binoculars for helping the Air Force and the Army look deep beyond the battlefield in the furtherance of the AirLand Battle deep-attack doctrine.

But there is much unspoken con-



This Brave 200 airframe has been the basic configuration of a succession of propeller-driven Boeing unmanned aircraft, including the Seek Spinner variant that the Air Force could someday deploy as a defense-suppression UAV. Boeing claims that its Brave-series vehicles are well-suited for a wide variety of missions, including reconnaissance, communications relay, and electronic warfare.

Air Force technicians secure Northrop jet-powered AGM-136A Tacit Rainbow UAVs in a B-52G bomb bay prior to a test flight. Preprogrammed to loiter on high and swoop down on enemy radars once they are turned on, Tacit Rainbow can be called a UAV, a cruise missile, or a standoff weapon—but not an RPV.

cern in the Air Force—and in other national defense circles—about the ability of those Joint STARS aircraft to survive while staying close enough to the forward edge of the battle area (FEBA) to keep their surveillance up to snuff. Precious fighter assets may have to be committed to protect the Joint STARS aircraft against enemy fighters bent on penetrating NATO airspace for just one purpose—knocking those surveillance aircraft out of the sky.

The UAVs' champions in the Air Force and elsewhere in the US defense establishment are careful not to class the unmanned aircraft as threats to manned aircraft. This would hurt UAVs in a hurry. Rather, the unmanned planes are always presented as complementary.

In telling Congress about the successful testing of "mini-RPVs" containing moving-target-indicator radar, DARPA's Dr. Colladay described the system as "an ideal complement" to Joint STARS "because of its local control, mobile penetration capability, and ability to get a higher-angle look at targets shadowed by terrain or foliage."

High-flying, long-loitering UAVs may also help some day in spotting Soviet mobile ICBMs that can be deployed over large areas, camouflaged, and covered and concealed by the natural landscape.

Robert Moore, DARPA's Deputy Director for Systems and Technology, told an Air Force Association symposium on strategic forces last June that the US should put a premium on developing the technology and the systems needed to spot and target those mobile ICBMs *(see page 50).*

Perking Up to UAVs

The US is hardly alone in its newfound fascination with UAVs. They are hot items in a growing number of nations in the Middle East and Southwest Asia. Egypt, for example, has been buying them in droves—from the very same US manufacturers who have never had much success in selling them to the Pentagon as peacetime staples.

European nations have perked up to the UAVs as well. NATO's military forces find them attractive for surveillance and for destroying and jamming enemy radars. Radar-homing systems being examined across the Atlantic are Northrop's jet-powered Tacit Rainbow, Boeing's propeller-driven Seek Spinner, West Germany's DAR (Drohne Anti-Radar), and Israel's Harpy.

Some NATO nations have expressed interest in Lockheed's Altair UAV—the "international" variant of the company's Aquila system—for surveillance behind enemy lines. The scaled-down Altair aircraft may well succeed where the more ambitiously sophisticated Aquila did not.

UAVs for electronic warfare are compelling but controversial. Brig. Gen. Noah E. Loy, USAF's Director of Electronic Combat Programs, says that the Air Force is "working with NATO right now on a drone jamming system" that shows promise.

"But the big problem with drones is that they have to complement the existing force structure and be integrated into it," General Loy continues. "They've got to be over there jamming at just the right time, at the right moment. If they're not doing that, then they're not doing any good. On the contrary.

"The last thing I need is to have a jamming drone go in too early and blow the cover of the rest of the force or go in too late and enter a flight path that we're trying to go through to get to the target area.

"So drones have got to be coordinated with the rest of the strike force, and this can be a very difficult problem. Once the drones take off, if they're preprogrammed, you have no control over them except to shoot them down."

Col. Manny Garrido, Deputy Chief of Advanced Programs in USAF's RD&A establishment at the Pentagon, agrees that "integrating the UAVs into the total force" may be the toughest part of the task of bringing them to operational maturity in all their many forms and missions.

"We're in a situation with UAVs that's not much different from the time when Billy Mitchell and Hap Arnold were trying to introduce the airplane into the inventory," Colonel Garrido says. "We're excited about the technology but we have to proceed with caution, get more experienced with UAVs, and find ways to use them in the right numbers for the right missions." ■