

# A new generation

*UAVs proved their mettle in the first gulf war and have steadily gained acceptance by the military. Companies are moving ahead, though at different rates, on designing and building a broad range of types. However, wider acceptance faces some barriers—including the issue of how these vehicles will be handled in the National Airspace System. While one major aerospace player appears to be hedging its bets for the moment, it is poised to reach for a bigger piece of “the next market,” which it says is expanding.*

**U**nmanned aerial vehicles (UAVs) have been called the “vampires” of military acquisition—rising up every few years since WW II, only to be buried until the next decade brings them a new shot at life. Operation Desert Storm changed that dynamic forever in 1991, when the low-tech, short-range Pioneer helped to identify artillery and naval gun targets, detected high-speed Iraqi patrol boats, and even became the first “robot” to which enemy combatants surrendered.

## **Progress and acceptance**

All three services spent much of the 1990s putting out requests for proposals and designing new applications for entire families of UAVs. Many of those efforts never came to fruition, but the advances made during that decade greatly reinforced the military’s acceptance of and demand for UAVs when the nation went to war again, first with Operation Enduring Freedom in Afghanistan, then with Operation Iraqi Freedom.

The new generation of UAVs sent to Southwest Asia included a broad array of types. One was the heavily utilized Predator, which already had proven its worth in the Balkans and, in 2003, became the first weaponized UAV. Others ranged from the hand-launched Ravens, used for quick area surveillance and reconnaissance, to the massive Global Hawk, a high-altitude, long-range, long-endurance platform with a wingspan as wide as a Boeing 737.

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# of unmanned aircraft

*Polecat is a flying wing UAS from the Skunk Works.*

Overall, over 700 UAVs of various types currently are flying daily sorties in the region.

That UAVs have become not just an accepted part of the U.S. military arsenal but a permanent and growing fixture was demonstrated in 2005, when the status of Indian Springs Auxiliary Air Field near Las Vegas, Nev., was upgraded to that of Air Force base. The new installation, renamed Creech AFB, inherited three Predator squadrons, with a fourth soon added, and now also is home to the Joint UAV Center for Excellence and the Air Force UAV Battlelab.

### Competing for the market

Most of the world's major aerospace companies—and hundreds of component manufacturers and small companies hoping to grab a piece of the action—have been heavily involved in competing for this rapidly expanding market.

There is one notable exception: Lockheed Martin, current holder of the “world's number-one military contractor” title and builder of America's two newest jet fighters—the USAF F-22 Raptor supersonic stealth air-superiority fighter and the F-35 Lightning II Joint Strike Fighter (JSF).

While major prime competitors such as Northrop Grumman and Boeing, and specialized companies such as General Atomics Aeronautical Systems and AeroVironment, have aggressively pursued UAV programs for more than a decade, Lockheed Martin currently is involved in only two. One is the Desert Hawk Force Pro-

tection Airborne Surveillance System, a small (54-in. wingspan) electric motor UAV in production for the Air Force and the British Army. The other is the Navy Broad Area Maritime Surveillance (BAMS) UAV, on which the company is teamed with General Atomics.

Desert Hawk is now the anchor UAV product of Lockheed Martin Electronics, where all future work on the aircraft has been transferred. If its team wins the BAMS contract, Lockheed Martin Maritime Systems & Sensors Tactical Systems will be the prime.

None of this is to say that Lockheed Martin has largely ignored the UAV market. Instead, it created a corporate-wide Integrated Product Team (IPT) that spent more than two years intensively studying the market, the technologies, and what the various business sectors within the company can offer with a competitive edge. One of the team's first decisions was to remove the focus from UAV platforms and look instead at the broad Unmanned Aerial System (UAS) concept, which includes sensors, ground control stations, data management, training, and so on.

At the beginning of 2005, Lockheed named Richard O'Lear, of its Integrated Systems & So-

*“We're trying to position ourselves in multiple areas for the next generation of UAV requirements coming down the line.”*

—Frank Mauro

*The successes of the relatively low-tech Pioneer during Operation Desert Storm opened the flood gates to a whole generation of UAVs.*



lutions division, as vice president for unmanned aerial systems and the corporation's point man for making those assessments. He put together an IPT of 30 people, drawn from each of the company's relevant business units, to inventory skills and production capabilities, strengths and gaps, what the company already has in-house or available from partners, or even what might be acquired.

"We were trying to answer two questions: Should Lockheed be in the UAS business at all—any element—and if so, what should we do and how do we do it?" O'Lear tells *Aerospace America*. "That's why we stopped calling it UAVs and went to UAS, because it is not just the vehicle but also the payload, all communications needed to operate the vehicle, all the support stuff on the

*"That doesn't mean we've just been sitting back. Polecat reflects we are making strategic R&D expenditures, pursuing what we do best—innovative and leading-edge technology—so when we break into the market with Polecat or its successors, it will be really discriminating technology, like the F-22 and F-35."*

—Richard O'Lear

ground (launch, recovery, training), mission management, processing (analysis and information dissemination), etc. Going to UAS gets to the end result faster—not just the vehicle, but what is it doing and how does it fit into the panoply of services to the decision maker.

"We have a tremendous footprint and a lot of domain knowledge throughout the UAS concept. We build platforms, handle payloads, we're in communications and support, mission management and ground control, and so on. So when you start driving Lockheed to [examine] what are our strengths and deficiencies, that sets up the stage for strategy construction, a comprehensive look at where we want to be and how to orchestrate the various moving parts throughout the corporation."

He points to the intelligence market as an example of the need to bring together a variety of components—satellites, manned and unmanned aircraft, surface and underwater systems.

"You can't do it all from space or air or with unmanned platforms without creating enormous inefficiencies; you really have to find a way to integrate air, space, ground, and maritime to get the most effectiveness for the best cost," O'Lear says. "That's a big driver in Lockheed Martin's overall strategy—we're in all those domains and have parts of all those components."

Even before creating the IPT, however, Lockheed had begun internal research and development efforts into new technologies and concepts, hoping to set itself up as the technology leader for the next generation of UAS requirements, not only from the U.S. military, but also for homeland security, law enforcement, commercial, and international applications.

#### **Polecat and other innovations**

The most recent example was unveiled at the Farnborough Air Show in July 2006—the twin-engine Polecat, a tailless "Horton" flying wing design, similar to a B-2 bomber. The previously secret Skunk Works prototype is intended to demonstrate technologies applicable to the Air Force's future Long Range Strike program. The Air Force is examining concepts from Lockheed, Boeing, and Northrop Grumman, with a goal of entering a formal system design and development phase in 2010 and achieving initial operational capability no later than 2018.

The Polecat is part of a family of designs based on the Horton wing and intended for both tactical and strategic applications, with flight times ranging from 10 to 23 hr. The plan is to take the 90-ft-wingspan demonstrator (9,000 lb gross takeoff weight) to 65,000 ft to investigate the aerodynamics of the shape at that altitude.



"We will use it as a flying asset to reduce risk technologies in the next generation of development. It also was a way to risk-reduce manufacturing technology," explains Frank Mauro, vice president-advanced systems development at Lockheed Martin Aeronautics. "We wanted to take 50% of touch labor out of the construction, using various large-scale composite and direct manufacturing and tooling techniques. We met the objective of really breaking our prototype paradigm and reducing touch man-hours by half. We virtually eliminated all fasteners, which is really the most labor-intensive part of putting an airplane together."

By using Advanced Composites Group's LTM45 room-temperature-cure carbon/epoxy composite, they also were able to use local ovens to create the required 160-F maximum curing temperatures rather than large, more expensive autoclaves.

The corporate IRAD (independent R&D) strategy, much of it in concert with DARPA, also included other aircraft:

- Vertical Take-Off/Landing Advanced Reconnaissance Insertion Organic Unmanned System, or VARIOUS.

- Morphing UAV: An unmanned combat air vehicle (UCAV) concept that uses in-flight shape changes to expand its flight envelope and provide long loiter, intelligence, surveillance, reconnaissance, and attack against time-critical targets.

- Cormorant Multi-Purpose UAV, or MP-UAV: A new class of aircraft that can be launched from and recovered by submerged submarines as well as surface ships.

- FALCON (Force Application and Launch from Continental U.S.): A hypersonic (Mach 10-15) UAS for strategic strike and reconnaissance.

"We have skipped a generation of UAVs and are looking at game-changing solutions," Mauro says. "One of those is the morphing activity, which is a unique way of making a UAV both be persistent and have responsive speed. We should be flying a demonstrator in March-April 2007.

"To support the Navy, we have Cormorant; we are going through multiple phases of risk reduction to prove a UAV can be submersed in salt water as well as launched and recovered from a submerged submarine. Most of the work is relative not to the flying vehicle itself, but to launch, waterproofing the design, and recovery. DARPA has set those bars for us to meet before moving on to the flying vehicle."

LM Aeronautics also is investigating the lift-fan approach from JSF as an alternative to rotorcraft for vertical missions. Mauro says wind tunnel models are being used to reduce risk as



All future work on Desert Hawk will be carried out by Lockheed Martin Electronics.

engineers try to develop a three-to-four-time speed variation from loiter to dash.

"We're currently doing risk reduction [on the FALCON], focused on the propulsion system, and will go through a series of tests in the next couple of years on that. We're also defining a demonstration program with DARPA for a scaled Mach-6 version that will take off and land on a standard runway. We hope to be under contract [with DARPA] within the next year and flying the demonstrator within three years thereafter," he says.

"The propulsion is a combination of a turbine and a scramjet in the Mach-10 version. We're looking at a less risky technology for the Mach-6 demonstrator, more of a hydrocarbon than a scramjet—a more near-term propulsion system. The full-size FALCON would be equivalent to a B-52 in size; the scale model will be about 50-60 ft long. It doesn't look like a traditional flying machine because of the speeds planned; it looks more like the space shuttle."

Technology evolution, risk reduction, improved manufacturing techniques, skillset development—all are at the heart of Lockheed's IRAD investment, "to be able to compete for a set of requirements to which people do not currently have solutions," Mauro adds. "We are looking to compete for second source as well. Obviously, those who currently have contracts have an advantage on current requirements, so our look to the future is to the next set of requirements."

### Controversy and hurdles

One of the most controversial possibilities for future unmanned systems is the UCAV, which Mauro says faces a host of problems—many of which already are being experienced by all of the UAVs in operation in Southwest Asia.

"We have seen the cycle start two or three times on UCAVs, with the Navy and Air Force first having their own programs, then combined to JUCAVs, and now that terminating and breaking apart, with the Air Force doing long-range



*The Morphing UAV uses in-flight shape changing to provide different capabilities, as in the loiter and dash modes.*

strike and the Navy looking at carrier-based,” he notes. “Automatic target recognition, bandwidth, and airspace management will be the biggest impediments to the proliferation of UCAVs in the future [for ground strike]. Whether an unmanned system can deliver weaponry has already been proven, but we don’t have the infrastructure to support a lot of them doing that. And it will be a long time before unmanned systems play the air-to-air role, to build the needed confidence in the autonomy required for air to air.”

Another area in which the corporation sees both internal strengths and experience as well as a considerable impediment to market development in the short term is the use of UAVs—military or civil—in commercial airspace. Once again, infrastructure, especially bandwidth, and confidence are the major hurdles. As part of the search for solutions, Lockheed Martin recently won a contract to support the FAA to develop the UAV integration roadmap into the National Airspace System.

“UAVs will be a permanent part of the landscape, but if we can’t deal with flying both manned and unmanned assets in the same airspace and have available bandwidth to get the data out, they won’t get much beyond where they are now,” Mauro says. “We can barely deal with the number of UAVs out there now—the manned flight crews call UAVs ‘FOD (foreign object debris) in the sky.’ Still, they have established themselves as a permanent resource for the warfighter; how much more they grow depends on how we deal with the infrastructure.”

### Lockheed’s gamble

Some might call the Lockheed approach a gamble—staying out of the current market in favor of IRAD to position themselves for the next market, which O’Lear says his team has determined is expanding, in both potential customers and missions.

“The only way to say it politely is we are late to market. I don’t mean that in a negative sense—Lockheed made some measured judg-

ments. With the F-22 and F-35, the number of dollars involved in UAS programs pales by comparison. A \$200-billion-plus F-35 program is 25 times the entire five-year budget for UASs,” notes O’Lear.

“Did that have a cost? Of course. We aren’t in the market the way Northrop and General Atomics are, but the market dollars don’t even come close to the F-22 and F-35. So why get interested now? Because the trend lines are all the way Lockheed would like to see them—new customers, missions, growing marketplace, both U.S. and international—so the \$6-billion market from five years ago is growing, and that makes it a much more attractive market.”

O’Lear’s IPT is now on stand-by, available for recall to address any future questions that may arise, but has completed its original tasks and filed its reports.

“We made 10 specific recommendations—both specific programs and in some cases technologies or skills or architectures that could be applied to a system of systems approach—and are pursuing each of them aggressively,” he says, but declines to provide details. “We try to play to our strong suit—leading-edge technology, combining one system with another, integrating diverse platforms, providing more through synergy than just through one system.

“We think we have some distinct advantages, and I hope the approach we are taking will pay off, with customers going with Lockheed for totally integrated systems, high-value technology, and good value for the dollar.”



What then, does the UAV (or UAS) future look like for Lockheed Martin—and its competitors?

“We believe it will be important, and there will be a hybrid, integrated view of manned and unmanned as we work both technologies to make as effective a system for the U.S. government as possible. And, ultimately, we don’t believe you can do one without the other,” Mauro says. “The technology differences between manned and unmanned aren’t that great; the core competencies are shared, and I doubt any company already in the market will fail to pursue both.

“It is a lot easier for the small guys to work unmanned systems, because the certification requirements are not as great as those for manned aircraft. But the major primes will have the technology base and core competencies to do both, and can’t take the risk that the evolution of unmanned is that it replaces almost all manned. They have to play both roles to survive in the future.” ▲



*Cormorant can be launched from and recovered by submerged submarines and surface craft.*