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# Beyond the border

## UAVs are unmanned but not unpiloted

**BY JASON PAUR**

With the sun setting behind the snow-capped mountains west of the airfield at Fort Huachuca near Tucson, Arizona, tonight's mission has been delayed a bit by a wiring harness that just arrived from Phoenix. As the ground crew works on the tarmac in dropping temperatures, pilot Cassandra Hunt sits warm and comfortable at the controls as she fires up the 750-shaft horsepower Honeywell turboprop. As the turbine spools up, breaking the silence outside, Hunt sits in left seat, her camera operator sits next to her in the right seat, and behind him stands Customs and Border Protection (CBP) Agent Pete McNall, with a second CBP agent sitting at a TV screen showing the view from the on-board camera. They're in a ground control station (GCS), which is a simple trailer like you'd see at any construction site. There's plenty of room for everybody, including the ground crew once they're finished outside and even the CBP Blackhawk pilots who will come in a bit later to touch base.

With confirmation from the ground crew that the Predator—a UAV, or unmanned aerial vehicle—is ready, Hunt nudges the throttle forward and works the pedals as she taxis to Runway 26 at Sierra Vista Municipal Airport-Libby Army Airfield. (Interestingly enough, the airfield is a mixed-use airport and there are several general aviation aircraft taking off while the team is waiting for its mission to begin.)

The ground crew follows the aircraft and there are spotters along the runway to ensure everything is clear. The pilot and observer also use the nose-mounted camera, which gives a 30-degree fixed view out front with both visual and infrared

PHOTOGRAPHY BY THE AUTHOR


cameras, and the gimbals-mounted camera on the belly to check the taxiway and surroundings.

McNall, a former Marine One pilot, is in charge of the unmanned aircraft operation at Fort Huachuca. He says the aircraft will go where agents on the ground report activity. "It depends on what the threat is; we like to fly to the threat." The crew is in communication with two Border Patrol agents next-door, who are in turn talking with fellow agents on the ground at various locations along the border. And to maximize the strengths of the Predator, much of the work is done at night, when, McNall says, many of the illegal crossings occur. "A lot of the activity happens under the cover of darkness."

Whenever missions are flown, the Border Patrol agents on the ground give information to the UAV team about specific locations where there is reported activity. On this particular night the team flies to a route regularly used by smugglers.

Once the UAV is in the air and directed to the target area by the agents, much of the time is spent with many sets of eyes scanning the infrared screen looking for hot spots and movement. The Predator UAV is flying at 19,000 feet (less than 14,000 feet agl), at around 85 KIAS, and is about 10 miles north of the border. It cannot be seen or heard from the ground.

### UAVs in use

UAVs have been around for many years. But since their implementation in Afghanistan in 2001, the development and use have accelerated both in overseas combat as well as domestically. Although there are several models being used by various government agencies, the one gaining most of the attention in the aviation community because of its use along the U.S. border is the Predator, manufactured by General Atomics Aeronautical Systems of San Diego.

The Predator is actually a family of aircraft including the Predator A with its 60-foot wingspan and four-cylinder turbocharged Rotax 914 engine and the Predator B with a 66- or 86-foot wingspan and a 750- to 900-horsepower Honeywell turbine engine. There are also different models of both the A and the B designed for specific missions, such as high altitude and long patrols. There are two Predator B models that are being used by agencies domestically.

One is a standard B model used by the Department of Homeland Security (DHS) for patrols on the Arizona border. The other B model is known as Altair and it has been modified for high-altitude work, including research for NASA and the National Oceanic and Atmospheric Administration (NOAA). A third, called the Mariner, is to be tested in the Caribbean later this year for maritime patrols.

Altair is the first UAV to receive an N number registration (Experimental) from the FAA, which it did in 2005 after extensive testing and fulfilling the same requirements that manned aircraft must follow, including operating limitations, maintenance programs, and training requirements for the pilot and observer. "We used every rule except for the seat-belt and oxygen requirements," says General Atomics chief pilot Tim Just.

The General Atomics pilots who fly the Predator are instrument-rated commercial pilots. Many continue to be active general aviation pilots and, like other commercial pilots, were hired after stints as instructors or from other entry-level professional pilot jobs (few are military or ex-military). Flight schools are another common source of Predator pilots, according to Just. "We get a lot of pilots out of Embry [Embry-Riddle Aeronautical University]." Pilots must have a minimum of 500 hours of pilot-in-command time before being hired, and they undergo on average just under 50 hours of flight training with the Predator before flying their first mission.

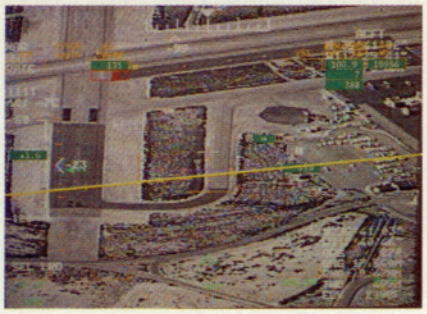
The General Atomics pilots fly most of the missions for the military overseas as well as for the DHS, NASA, and NOAA domestically. Training is ramping up for both military and law enforcement officers, such as the Customs and Border Protection agents.

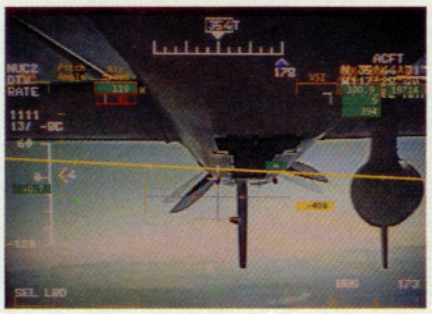
The roughly 50 pilots currently employed by General Atomics must fly a minimum of 100 hours a year to stay current, as well as complete instrument refresher courses, flight checks, and several other exams and evaluations similar to those required for other commercial pilots.

Those who fly the Predator like to point out that the aircraft is unmanned, but not unpiloted. In fact, there are often two or more pilots working in shifts to fly the aircraft on missions ranging from helping scientists watch thunderstorm development over Florida or spotting forest fires over California to monitoring the borders in Arizona and searching for military targets in Afghanistan. Predators can stay aloft more than 30 hours; pilots often work in two-hour shifts, each taking a turn at the controls in the GCS. In addition to the pilots, there is a camera operator whose sole job is to operate the gimbals-mounted camera mounted on the belly of the Predator. "We've really become a pickup truck," says Just. "The purpose of the airplane is to be a platform for the camera."

With thousands of Predator hours under his belt, pilot Jason McDermott says the novelty of piloting the aircraft wore off long ago. "The work has become the story, not flying the UAV." On one trip to Florida to monitor thunderstorm development with a group of scientists, a call came from a controller asking how the ride was at Flight Level 210—"couldn't be any smoother if I were sitting on the ground," McDermott quipped. Although his response was intended as a bit of a joke, McDermott points out that with the on-board cameras and instruments, he knew the Predator's ride had been smooth for quite a while. "We can give accurate pireps with all the instruments on board," he says.

Although flying the Predator may no longer be the story for the pilots, flying it in the national airspace continues to be the story with the FAA, which has yet to make a decision on how to regulate the operation of unmanned aircraft in the United States.





**In the Predator cockpit inside of the ground control station at Fort Huachuca (top left), the pilots sit on the left with the camera operator on the right. The crew often overlies the heads-up display over the belly camera image showing the artificial horizon (yellow line) as well as flight instruments (left to right below)—infrared image of the airport during training; looking back at the tail with propeller; and view out the nose.**

### How to fly a UAV

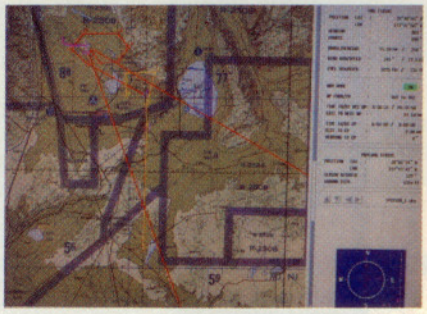
Flying a Predator isn't too different from flying any other aircraft. The right hand rests on a side stick and the left hand rests on a throttle. And the rudder pedals are in the usual place (the aircraft does have a steerable nosewheel). The main difference is that while sitting at the controls, the pilot is looking at two large monitors and is just as likely to be typing on the keyboard as providing inputs with the stick. The keyboard inputs are similar to managing a flight director in a manned aircraft. "We spend 90 percent of the time on autopilot," says McDermott.

Although the Predator B models can fly at more than 220 KIAS, these speeds are rarely used and usually only to transit quickly to a new area. Most of the speeds flown are less than 100 KIAS; loiter speeds are typically around 85 KIAS.

In flying the simulator for an A model, the aircraft was found to have very docile flying qualities. "When the airplane is easy to fly, the pilot can concentrate on other things," says McDermott. (He points out with a smile that the Predator is one of the only aircraft where flying the simulator "feels" the same as flying the real thing.) Rotation happens at 65 KIAS and the climbout is flown at 75.

One interesting aspect of flying the Predator compared with most GA aircraft is that it is fly by wire. The command-and-control input means that the pilot is effectively instructing the airplane what to do and the aircraft then holds the desired pitch or roll attitude. So, after takeoff, in order to turn downwind, the pilot moves the stick until the desired attitude is reached, for instance, 10 degrees of bank, then squeezes the "trim button" on the stick. The pilot then allows the stick to return to center and releases the button. The aircraft will stay in the 10-degree bank hands off until commanded to do something else (or it runs out of fuel).

**Moving map display shows ground tracks and the emergency mission track.**




**Altair in the pattern during training over Gray Butte in the southern California desert.**

## Sharing the airspace

The lingering question in the United States regarding the Predator and other unmanned aircraft systems (UASs) continues to be how the remotely piloted aircraft will be integrated into the national airspace. AOPA has maintained that certification of UASs is important to ensure safety and make sure UAS operations don't result in more flight restrictions. AOPA believes UASs currently lack the necessary technologies to safely operate in a "see and avoid" environment. In order to safely operate in the airspace system without segregation and without any negative impact on general aviation, the UASs need to be certified and operated like piloted aircraft. As UASs begin to enter mainstream airspace areas, without spotters or chase planes, AOPA will strive to ensure that these aircraft are operating at the same level of operational safety as the pilots and aircraft flown by the AOPA membership.

The manufacturer, General Atomics, as well as Customs and Border Protection (CBP) officials interviewed for this story expressed the desire to operate UASs without TFRs. "The intent is to minimize the effect on general aviation aircraft," says CBP UAS program director Michael J. Pitts. Pitts adds that with the addition of new cameras on the Predator, TFRs are no longer necessary because the aircraft can operate from higher altitudes.

Currently the Predators based at Fort Huachuca operate under a certificate of authorization from the FAA allowing them to take off from the mixed-use airport with spotters on the ground while other aircraft, both civil and military, are held for 5 minutes before and after the takeoff. The Predator then climbs through the R-2303 airspace and into Class A airspace, where it is in positive control with air traffic controllers who have been trained to handle the Predator in their airspace while it patrols the border.

Currently the Fort Huachuca-based Predators highlight the difference between government-operated UASs and those operated by commercial interests. Although the government-sponsored UASs can apply for a certificate of authorization, commercially operated UASs must apply for an Experimental airworthiness certificate. Only two Experimental UASs were operational at press time. The COA process does force the operator to mitigate sense and avoid requirements with chase planes and restricted airspace—but the tradeoff can mean TFRs for other pilots to navigate.

According to FAA spokesman Les Dorr, as of this writing the "road map" for UAS use was to be ready by early summer. "Before we can make any decisions on going further, we have to be satisfied that those two requirements, and they're simply nonnegotiable requirements, of see and avoid and command-control-communicate have been met." Dorr says that the road map will provide the guide for UAS use in the future. "That will be our plan for integrating UASs into the national airspace and also obviously for certificating future designs."

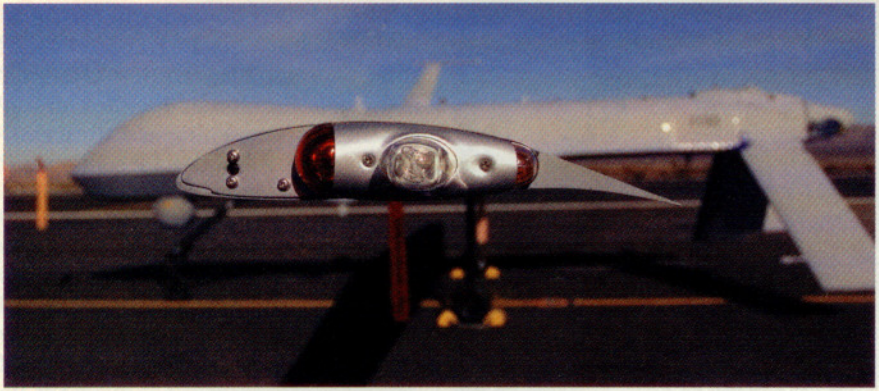
The airplane can be adjusted with the stick without pushing the button, but it will return to the last attitude, which was set with the trim button. The pedals are rarely used during flight. It does take some getting used to for pilots more accustomed to cable and pulley flight controls. With the aircraft flying at 100 KIAS on the downwind, the turn is made to final and power is reduced until the airspeed reached 75 KIAS, and the stick is moved until the desired pitch attitude is achieved. The aircraft is flown to the runway with small corrections of move stick-squeeze button-release, which are repeated as needed. At about 60 KIAS, the Predator A is flared and touches down. All in all, it's a fairly easy aircraft to fly.

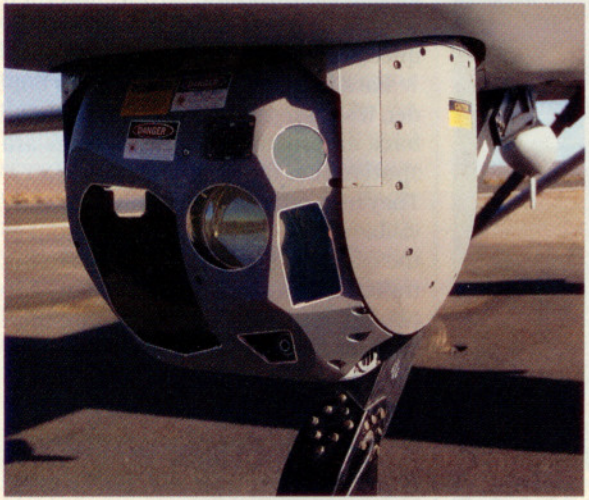
The aircraft has triple redundancy in the flight control systems and twin servos for each aileron and elevator. There are no flaps, although the aircraft can be slipped. Speeds for the Predator B are slightly higher in the pattern (75 KIAS on final, for instance), making the A and B aircraft fairly similar to fly despite the more than 600-horsepower difference.

The ground control station consists of two identical stations side by side, separated by a rack of computers as well as the radio and a few other instruments. The pilot sits in the left seat while the camera-payload operator sits in right seat. Because they're identical, the stations can be interchanged with the push of a button if needed. In normal operation the camera operator uses the joystick to move the gimbals-mounted camera-instrument ball, with aileron inputs turning the camera and elevator inputs moving it up and down. The throttle is used as the zoom.

Typically the pilot has the lower screen showing the view out the nose camera of the aircraft, which gives a fixed 30-degree view. A heads-up display showing all necessary flight instruments, similar to a modern glass-cockpit display overlies the view on the lower screen out the nose. On the upper screen the pilot usually has the moving-map display that shows the track of the aircraft as well as many other navigational data points. Screens showing engine and flight data as well as mission information also can be viewed at anytime. As is typical of glass cockpits, there is a wealth of information available to the pilot.

On the moving-map display the pilot and camera operators see a large amount of information, including the current track and an emergency mission track, which is constantly being updated by the pilot. In the case of a communication failure, the on-board system flies the Predator to this predetermined track (typically an oval-type course similar to a holding pattern), where the airplane will remain until the problem can be resolved. However, according to General Atomics, in more than 240,000 hours of flying, there has never been an incident





**A microwave communication link with Predator A at El Mirage (far left). Predator A awaits a training mission at General Atomics' El Mirage facility (above). The payload is a gimbals-mounted camera that can include a wide array of potential instruments including high-resolution visible and infrared cameras as well as muzzle-flash detectors and laser-imaging devices (left).**

where the pilots have been unable to regain a lost data link.

The ground control station uses both microwave and satellite links to the aircraft. And although any ground control station could operate any aircraft worldwide via satellite, crews prefer to use microwave stations during takeoff and landing for the slightly quicker response time (it's a matter of less than a second). Ground control units typically are mounted in a small trailer such as the one at Fort Huachuca, but Predators also have been flown from the back of a Humvee, a submarine, and even other aircraft.

## On the border

With the exception of a few scientific missions, the main story involving UAVs in the United States is the Predators flying border patrol in southern Arizona. The Predator B that the DHS uses in Arizona first flew in 2005. The program was put on hold after the original aircraft crashed in April of last year when the fuel was accidentally shut off during a switching of controls. "We lose airplanes for the same reasons manned airplanes crash," McDermott says of the problem that brought down the airplane—pilot error.

The new Predator B operating at Fort Huachuca has been based there since October 2006. Until mid-March of this year the aircraft operated only in existing restricted airspace, until controllers at the Albuquerque center were trained to handle the UAV and a certificate of authorization was granted for operation outside the restricted airspace. As of this writing, no temporary flight restrictions (TFRs) were being issued because the aircraft climb into Class A airspace through the restricted airspace around the airport and then remain in positive control with Albuquerque center during the mission.

Back in the air over the Arizona border, it's been just over an hour of flying back and forth when two figures are spotted just inside the United States. They're in total darkness, but are clearly visible on the infrared screen in front of the camera operator, the agents in the trailer, and the agents next-door. The two figures mill around for more than an hour before spending another hour slowly making their way north. McNall won't send out the Blackhawk until the suspects are at least a mile and a half inside the United States because the noise of the helicopter gives the smugglers about a 10-minute warning, and most simply run back across the border.

But on this night, the two figures eventually join up with another eight people who, because of the "cold" signature from their backs, agents guess are wearing backpacks with drugs inside. The group works its way far enough north, and the Blackhawk is sent out. Shortly after takeoff, the group can hear the helicopter and can be seen on the screen scrambling to hide under one of dozens of trees. But there's no hiding; the Predator is painting them with a laser, and moments later the Blackhawk appears on the infrared screen to those in the trailer. The pilots are using their night-vision goggles to fly directly to the smugglers and set down only yards away in the pitch-black darkness. After a short chase, and a little bit of herding with the helicopter, the group is arrested and is discovered to have more than 365 pounds of marijuana.

The government plans to increase the use of Predators and other UAVs within the United States in the coming years. In addition to having more aircraft patrolling the southern border, there are plans to have aircraft based in Grand Forks, North Dakota, to patrol sections of the northern border. The U.S. Forest Service plans to again use the Altair to monitor forest fires in the western United States, and both NASA and NOAA also have continued missions for the high-altitude Altair.

There has yet to be any resolution on how UAVs will be integrated into the airspace, although with the interest and usage coming from many different parts of the federal government, it does appear that their use will continue to grow both domestically as well as in other parts of the world. AOPA

*Jason Paur is a writer and photographer living in Seattle.*

## SPECSHEET

**Predator B**

Powerplant: Honeywell TPE 331-10T turboprop

**Performance**

- Max altitude: 50,000 ft
- Max speed: 220 KTAS
- Max endurance: 30+ hr

**Dimensions**

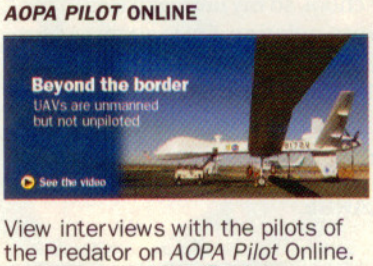
- Wingspan: 66 ft
- Length: 36 ft
- Propeller diameter: 9.2 ft
- Weight: Empty 3,700 lb
- Max gross takeoff weight: 10,500 lb
- Max payload
  - Internal: 800 lb
  - External: 3,000 lb
- Data link: C-Band Line of Sight, Ku-band Beyond LOS Satcom
- Guidance tracking: INS/GPS
- Payloads: Maritime surface search radar, communications relay, Electronic Signals Intelligence, Hellfire missiles, Guided Bomb Unit-12 laser-guided, GBU-38 JDAM (joint direct attack munition)
- Launch: Conventional wheeled
- Recovery: Conventional wheeled
- Structural material: Semimonocoque composite using preimpregnated bidirectional graphite skin and Nomex honeycomb stiffening panels

**Uses**

- Reconnaissance, surveillance, target acquisition/designation, weapons delivery, communications relay, electronic warfare, SIGnals INTelligence
- Manufacturer: General Atomics Aeronautical Systems Inc., United States

**INTERACTIVE ▶**

***AOPA PILOT* ONLINE**




View interviews with the pilots of the Predator on *AOPA Pilot* Online.
**www.aopa.org/pilot/Predator**