(Continued from page 185)

dust, but it decided to go ahead anyway. He has tried to make the best of it since, noting that the decision permits the agency to use cost-benefit analysis for safety regulations. "Further, the Court did not decide on the legality of cost-benefit analysis under other statutes," such as those administered by the Environmental Protection Agency or the Department of the Interior, he notes.

Initially, there was some confusion about whether the opinion specifically prohibited cost-benefit analysis or merely said it was not required. But lawyers at the Labor Department and in the environmental groups now agree that any agency standard based on such a comparison can be challenged and overturned. OSHA's regulation writers will no longer have to fulfill President Reagan's Executive Order mandating cost-benefit comparisons throughout the federal government. (It is noteworthy that a recent study by the Congressional Research Service concluded that the order may not be legal, although OMB is unlikely to withdraw it.)

OSHA still has enormous discretion in setting standards. In the past, for example, standards have often been set low enough to require state-of-the-art technology to limit workers exposure. Auchter could just as well determine that standards incorporating such technology are unfeasible, and that less stringent efforts need rely only on proved control technology. Relaxation of the standard with this approach would approximate that achieved if costs were taken into account. Auchter could exercise the opportunity when and if he proposes an exposure standard for a hazardous chemical that is currently unregulated.

In the strip-mining decision of 15 June, the Supreme Court upheld provisions of a law passed in 1977 that similarly allows little consideration for the costs of mining reclamation operations. Mine owners and operators in Indiana and Virginia had attacked it as unconstitutional, claiming that its requirements violated due process and unjustly outlawed certain inexpensive mining procedures. The Court said that "Congress acted rationally" in writing such strict rules, given the mining industry's record of environmental destruction, amply documented in congressional reports that led to the law's enactment. The Court's unanimous opinion, written by Justice Thurgood Marshall, overturned lower court rulings and upheld controversial requirements that prime farmland and other areas be returned to their original contour and productivity.

The narrow ruling skirted claims that mine owners are entitled to some form of compensation if they are unable to continue mining under the act. The "issue remains available to, and may be litigated by, any owner . . . whose property interest is adversely affected by the enforcement of the Act," writes Justice Lewis Powell in a concurring decision.

More important, the opinion fails to specify how enforcement should be conducted. Interior Secretary James Watt has curtailed mining inspections, and recently announced plans to close six regional enforcement offices. Plans are under way to reinterpret many existing regulations to favor mine owners (*Science*, 15 May, p. 759). As in the cotton dust decision, the Court affirmed the soundness only of the law itself, giving Reagan appointees an opportunity to continue deregulation.

—R. JEFFREY SMITH

The U.S. Flight from Pilotless Planes

Glory-bound pilots in the U.S. Air Force veer away from a simple technology that can save dollars and lives

The Israelis have long enjoyed aerial supremacy over Lebanon, searching out Palestinian strongholds with impunity. When in May, Israeli photo reconnaissance drones brought back pictures revealing batteries of Soviet-made SA-6 antiaircraft missiles, their silver warheads gleaming in the sun, the Israelis threatened to strike. The Middle East braced for a violent showdown. What ensued, however, was a battle not of men but of machines. The missiles in Lebanon shot down several Israeli drones. Far from a setback, the loss of these nonphotographic "hero" drones provided the Israelis with valuable electronic intelligence about ways to knock out the missile threat. Right before it dies, a hero drone sends back information about the signals that guide missiles to their targets. Later, jammers can disrupt these signals.

The current missile crisis has not escalated into a full-scale conflict that might require such maneuvers. A few years ago, however, it was a battlefield coup that first sparked Israeli respect for drones. At the start of the 1973 October War, Egyptian missile crews thought they had scored a victory when they knocked out a whole Israeli flying formation. As the Egyptians reloaded, however, a second wave of Israeli fighters slipped through and knocked out vital targets deep within Egypt. Later, when the Egyptians examined the wreckage of the first Israeli wave, they discovered not complex jet aircraft but small, inexpensive decoy drones that the Israelis had electronically enhanced to look larger on Egyptian radars.

As all this suggests, the Israelis have latched onto a simple and elegant military technology.

And the U.S. Air Force? The question is especially relevant since drone and remotely piloted vehicle (RPV) technology was pioneered in the United States and the Israelis buy many of their vehicles from U.S. manufacturers. The U.S. Air Force, however, has turned its back on the technology. The main reason, admitted by some Air Force officials, is that it offers little by way of career opportunity and nothing by way of battlefield promotion and glory. In short, the neglect of drones is a classic example of how military prejudice and the lack of a constituency in the Pentagon has ruled out a simple technology that can save billions of dollars and untold numbers of lives.

Not that this has always been the case. Expediency on occasion can overcome the most profound predilection in the U.S. military. During the Vietnam War, the United States flew more than 3000 RPV sorties over North Vietnam, the aircraft automatically photographing targets and recording damage after manned bombing missions. Fewer than 10 percent were shot down. In peacetime, however,

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interest has waned, the last RPV squadron being put to rest in 1978. Currently, no service has operational units, although the Army has an RPV research and development program. In March, the Air Force ended its sole R & D program for RPV's. (Technically, drones have their own internal instructions, while RPV's are controlled from a remote location. In practice, however, the labels are often used interchangeably. In an altogether separate category, and not addressed in this article, are cruise missiles.)

All this may soon change, however. For the past 3 years, Congress has mounted increasing pressure on the Air Force to look into drones and RPV's. Technological developments are making various uses more and more attractive. The deft performance of the Israelis is starting to sink in around the world. Finally, the General Accounting Office has described some of the advantages of drone and RPV technology in a recent report* that has been widely read in industry and government circles. Even the Air Force now avows interest, though what they will do about it remains to be seen. "It's true that user apathy is a big block," says Tom Jonak, program director for RPV's in the R & D office of the Air Force Chief of Staff. "But drones are coming back into vogue. There's a lot of missions that can be handled better by drones than pilots, and people here, pilots, are starting to recognize this. Drones are especially cost effective. The question is not whether we will have a program but what the program will look like."

The development of modern-day drones began in 1959 when the Ryan Aeronautical Company (now Teledyne Ryan) put into production its Firebee, a target drone. (Target drones, in contrast to the vehicles described in this article, are currently used throughout the services.) The Firebee was a subsonic, jet-propelled unmanned aircraft, remotely controlled from either another aircraft or a ground station. The evolution of this target drone into an operational RPV dates from the Cuban missile crisis of 1962. A U.S. spy plane was shot down over Cuba, and because only two more U-2's were available, the U.S. government started a crash program to develop RPV's for reconnaissance.

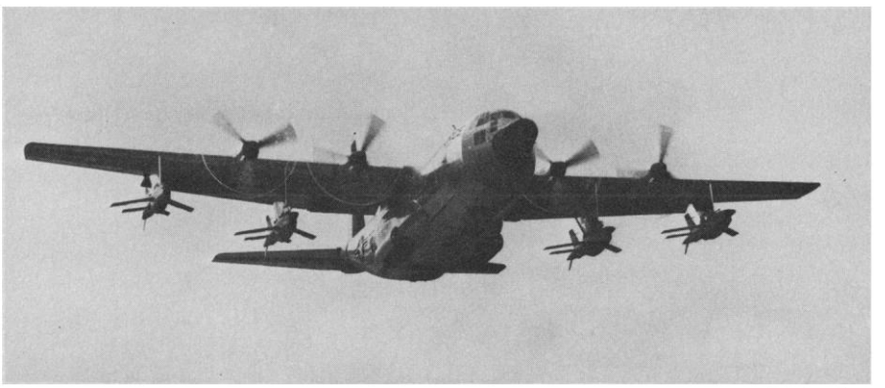
In 3 months, Teledyne Ryan produced its first model 147 RPV, based on the Firebee. It was tested against U.S. air defense systems and was able to make repeated penetrations. The 147 became the first member of a family of RPV's that now numbers more than 20 variants. (Teledyne Ryan since the early 1970's has sold dozens of drones and RPV's to the Israelis.)

The first public disclosure that RPV's had superseded U-2's for certain U.S. missions came in 1965 when the People's Republic of China displayed the remains of a U.S. unmanned reconnaissance aircraft that had been shot down.

During the Vietnam War, RPV's flew over North Vietnam at both high and low levels, eluding the heavy and effective North Vietnamese defenses by their speed and small size. In addition to photographic missions, RPV's dispensed propaganda leaflets over North Vietnam and carried electronic listening devices to pick up and relay enemy broadcasts.

After the war, development continued for a while, the emphasis shifting to the refinement of command and control links so that RPV's could be adapted for tactical bombing. However, resistance within the Air Force, increasing costs, and the unreliability of complex control circuitry (known as avionics) brought an end to these programs. The R & D programs of the past few years have stressed the development of less complex aircraft (often powered by small prop engines rather than jets) whose missions do not include tactical bombings.

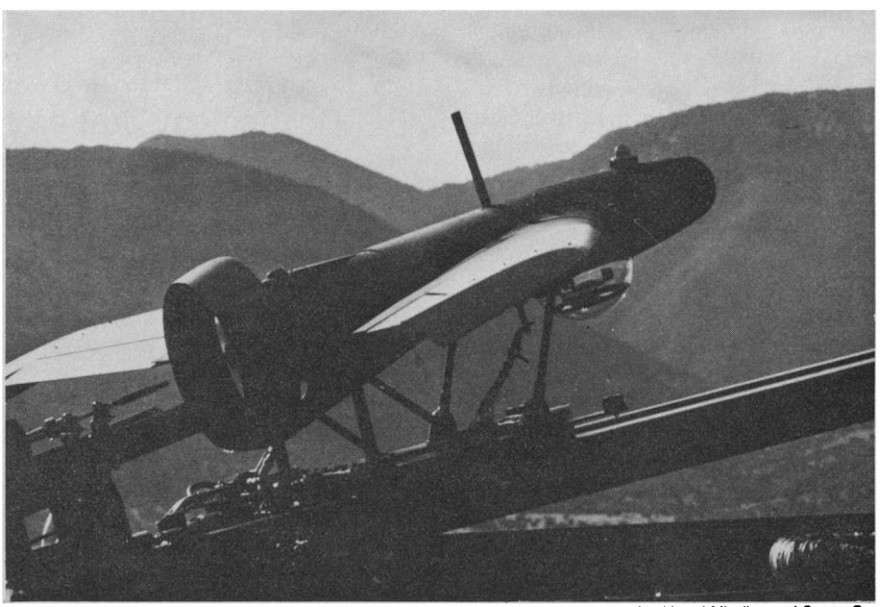
The advantages of RPV's and drones



Teledyne Ryan

Drones over Vietnam

Four Teledyne Ryan drones known as Firebees are readied for takeoff under the wings of a Lockheed DC-130 Hercules, from which they are controlled. They can carry 500-pound bombs or packets for electronic warfare.



Lockheed Missiles and Space Co.

A drone for the Army of the 1980's

The Aquila, here seen being readied for launch from a rail, can fly either preprogrammed or manually directed missions over enemy territory, sending back television pictures to a command center.

**DOD's Use of Remotely Piloted Vehicle Technology Offers Opportunities for Saving Lives and Dollars.* MASAS-81-20 (General Accounting Office, Washington, D.C. 20548, April 1981).

Teledyne Ryan

Drone over the Caribbean

A Firebee takes off from the U.S. Navy's Caribbean Sea Weapons Range.

are numerous, including the elimination of pilot and crew losses, the lowering of operating costs, and the increasing of mission survivability. Though RPV's clearly could not replace all manned missions, they could replace some and probably save lives. Of the American prisoners of war held in Southeast Asia, almost 90 percent were downed pilots and crewmen. RPV's are inexpensive. They need no crew support systems (ejection seats, oxygen systems, air conditioning, and armor plating). Cheap materials such as fiberglass, plastic, foam, balsa wood, fabric, and cardboard can be used. They consume little fuel. A study by the Rand Corporation estimates that the annual peacetime fuel consumption of an F-4 Phantom jet fighter is 460,000 gallons, while an RPV performing the same mission would use 2,280 gallons. Small RPV's are difficult to detect on radar, and if detected are almost impossible to hit with combat fire. Many of the new mini RPV's on the drawing board would employ stealth-type technology, making them invisible to radar.

Missions where drones and RPV's could be used with much success, according to the GAO, include intelligence collection, communications relay, reconnaissance, search and rescue, atmospheric sampling, electronic warfare, dispensing radar-inhibiting chaff, air-to-air defense, interception, surveillance, and airlift.

Despite the spectrum of applications and the potential savings in manpower and money, the Air Force has veered away from its sole RPV development program, the Locust (for Low Cost Expendable Harassment Vehicle). The program was started in a half-hearted way with the Federal Republic of Germany, and when the Germans recently had budget problems, the Air Force put the program in limbo. A true drone rather than an RPV, Locust would have waged electronic warfare in a deceptively simple manner. Land-based radars constantly advertise their location with their beams. A Locust drone would simply follow the beam and demolish the radar with a conventional warhead. If the operator of the radar station saw the drone coming and switched off the radar, Locust would circle, and continue its journey after again picking up the radar signal. If the radar station stayed off, then the drone would have accomplished its mission in any event. The only short-term way to eliminate the drone would be missiles. Since the Locust drones would be very inexpensive, however, planners envisioned hundreds of them flying over radars, making a missile offensive a difficult task.

"Procurement was slated for 1983," says Jonak, "but right now Locust is not funded. We're still reassessing just what the program is going to look like." Before the program was scrubbed, the Air Force was putting a paltry $6 million into R & D for the Locust.

It is ironic, but the place where RPV development is currently getting emphasis in the U.S. military is not in the Air Force but in the Army. For 1981, the Army is spending $61 million on its Aquila program (Aquila is latin for eagle). A mini RPV with a wingspan of only 13 feet, Aquila will weigh 200 pounds and will carry a TV camera and a laser designator. It will perform forward battlefield observation, sighting targets and directing laser-guided missiles. As a general reconnaissance vehicle, it can also help the Army take advantage of the greater range of conventional artillery. "The system," says F. David Schnebly, an official at Lockheed Missiles and Space Co., the prime contractor, "will provide high-quality, real-time reconnaissance of targets far beyond the normal range of the ground observer and deep into enemy territory."

This is the sole R & D program sponsored by the U.S. military, and its culmination in a finished product is years away. Just when the Air Force might get ready to embrace the concept of pilotless planes is anyone's guess. In the meantime, U.S. companies such as Teledyne Ryan and Lockheed Missiles and Space Co. continue to court the growing market for drones and RPV's around the world. Company representatives who recently returned from the 1981 Paris Air Show say that interest and orders are reaching new heights. The Israelis are so taken with the technology that they have started manufacturing their own drones. It would seem to be time for the U.S. Air Force to fall into line, to put aside some of its visions of glory, and to get serious about a simple technology that offers savings in dollars and lives. Shortages in the military of manpower combined with the ever-increasing cost of jet fuel only make the move to drones more sensible. As the House Armed Services Committee has reported: "We would like to convey support for the requirement to have RPV's in our military inventory in view of their demonstrated performance in actual combat. The committee has been concerned over the decline of Service support for these necessary systems that not only serve as force multipliers, but could in many instances perform those missions that greatly endanger our pilots."—WILLIAM J. BROAD

Military prejudice has ruled out a simple technology that can save billions of dollars.