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RPVs in the MILITARY SERVICES

An EMERGING TECHNOLOGY with MODEST INVESTMENTS

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Department of Defense (DoD) sees the area of remotely piloted vehicles (RVP) technology as being a newly emerging one that has a real, very high potential for improving the effectiveness of our military forces with modest investments of funds as opposed to those in other areas.

I think it is important to attempt to define remotely piloted vehicles a little more carefully since remotely piloted vehicles are often confused with guided missiles of various types.

The principal distinction that we would make in discussing the remotely piloted vehicle is that an operator intervenes in the operation of this vehicle and it is distinguished from a missile in that in most cases it is returned to its user at the end of its mission.

There are tremendous broad concepts or areas of application that we can think about when we talk about remotely piloted vehicles. The first one is high altitude, long endurance applications. These are applications where the endurance of a human being is a requirement for vigil and remaining in a high state of emotional readiness. This action is a very demanding thing for a long period of time.

Therefore, these high altitude, long endurance vehicles have a way to relieve the stress on the operators involved and perform functions that would be difficult to perform with a man present.

Secondly is the medium scale multi-purpose vehicles which we envision to be in the 500 to 5,000 pounds gross weight category and having intermediate periods of endurance, say, two to six or seven hours.

The purposes we envision for these kinds of vehicles are strike, the delivery of weapons, reconnaissance over the close areas in the battlefield, and electronic warfare support, both in terms of carrying jamming equipments and in terms of the ability to dispense decoys in an area of interest.

And, finally, the performance of the job of designation for weapons requiring designation, specifically such as laser guided weapons.

In this case, these RPVs could provide target location in detail and designation for weapons that were

A remotely piloted vehicle releases an inert, 500-pound bomb during tests at the White Sands Missile Range, New Mexico. Unmanned jet-powered vehicles have been posed in newly-defined missions ranging over a broad spectrum of defensive and offensive capabilities.

delivered by other vehicles, either by manned aircraft or by, for example, indirect fire from artillery using homing artillery shells.

The third category is the so-called mini-RPV. And when we think about the mini-RPV we think technologically of something scaled up from model airplane technology rather than scaled down from manned aircraft technology.

I think the most important aspect of this promising area is the fact that it is potentially quite inexpensive and potentially very technical to operate in the field.

The changes that have occurred technologically in this area are indeed impressive. In the past decade even the model airplane technology has moved from an era of technologically inferior reliability to one presently of technologically superior reliability, and it is this change in reliability that we would hope to be able to exploit in using the mini-RPV operationally.

Here the principal roles are designation, target acquisition, and identification close to the point of contact of the battle.

The mini-RPV intrinsically must be a short range, very short endurance vehicle, simply by virtue of its limited size.

However, it carries with it some advantages of simplicity—physical simplicity, simplicity of the mechanism to retrieve it as opposed to those associated with the large vehicles.

So it is in these three areas that our general program activity occurs in RPVs.

In the areas of technology we have to concern ourselves with propulsion, the observables of the vehicles, the sensors involved in performing their functions, and the command and control of these remotely piloted objects.

I have not addressed the airframe technology. It is a technical area because we believe that the airframe technology is not unique to RPVs and, therefore, it is not necessary to carry any highly specialized or any specifically specialized work of a technological nature in this regard.

In the propulsion area the problem is really applying propulsion that has been developed for other purposes and to understand it well enough so that we can move equipments that have been developed for other purposes into use in RPVs in the most economical way.

Basically, the choices of reciprocating engine or turbo-prop engine or turbo-fan or turbo-jet engines are issues of endurance. One wants to process the vehicles involved and the size of the vehicle and the altitude at which the vehicle operates. (Therefore, choices of propulsion are very important with respect to the high-altitude long endurance vehicles such as the Compass Cope, which I will discuss a bit further, but are less pressing in terms of their alternatives in the smaller sizes.)

Indeed, when one gets to the mini-RPV the propulsions are very limited. They are specifically at the moment limited to reciprocating engines.

However, that limitation is not a restrictive limitation. It is an adequate one.

The technology of observables is a very important and interesting aspect of RPVs and this is because it appears potentially possible for us to make remotely piloted vehicles whose radar cross sections are a tiny fraction of a square meter, a few thousands of a square meter.

Thus, we are talking about a vehicle of perhaps limited physical size which is essentially invisible to radar. Vehicles of small sizes also are very difficult to observe visually, and if proper attention is made to shrouding the propulsion sytems, their IR visibility can be made very small and under the right circumstances sound significance of their propulsion can be made low.

So technological attention to reducing the observables of this class of vehicle seems to be a very exciting and important direction to pursue.

WHAT'S OVER THE NEXT HILL?

This [illegible] Mini-RPV [illegible] for the Army by Teledyne [illegible] Aeronautical is designed for a broad spectrum of applications including target acquisition and designation, surveillance, reconnaissance, weapons delivery and electronic intelligence gathering.

by

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When Hannibal crossed the Alps and Washington crossed the Delaware the basic question facing both field commanders was "What's over the next hill?" Today, the same question faces the unit commander. The answer becomes more important as the capability of the enemy to deny surveillance on and near the forward edge of the battle area (FEBA) gains in terms of sophistication. While technological improvements have moved the "next hill" further and further beyond the FEBA, the entire key to effective employment of new weapons lies in that knowledge.

How does the Army approach this problem? U.S. Army Training and Doctrine Command (TRADOC), Ft. Monroe, Virginia, feels that the answer may lie in the effective development and employment of the mini remotely piloted vehicle (RPV). Thus, in February 1974, the Army's mini-RPV program found a new home in the RPV Division of the Weapons Systems Management Office, U.S. Army Aviation Systems Command (USAAVSCOM).

Over the last decade the Army has amassed a significant amount of experience in the limited application of remotely piloted vehicles—drones. A remotely piloted vehicle is an unmanned aerial vehicle that is controlled from the ground through an electronic data link, while a drone is pre-programmed before leaving the ground. The differentiation between target drones and RPV/Drones lies in the purpose for which the vehicle is to be used. The RPV/Drone carries equipment (sensors) for surveillance, reconnaissance, target acquisition, artillery adjustment, and weapon delivery. Within the RPV/Drones a distinction between the size of the RPVs is made (not yet commonly accepted); mini—less than 200 pounds, midi—200 to 5000 pounds, and maxi—greater than 5000 pounds. The Army program is concerned only with the mini- and the midi-RPVs, with the concentration of effort in the mini-RPV area.

The initial effort in the mini-RPVs began in the Department of Defense (DoD) with the Advanced Research Projects Agency (ARPA) investigating RPVs weighing less than 60 pounds, carrying daylight TVs and laser designators. Having demonstrated concept feasibility in experimental stages, the Army became interested and a program was initiated in January 1973. The objective was to demonstrate the feasibility of employing mini-RPVs with a primary mission of laser designation for laser-guided weapons and conventional artillery adjustment.

This program, called Remotely Piloted Aerial Observer Designator System (RPAODS) was assigned to the U.S. Army Electronics Command (ECOM). Limited funding was provided to conduct a combination hardware and analytical experimentation program. Contracts already initiated by ARPA were assumed by ECOM and off-the-shelf hardware was obtained for the flying portion of the program conducted at Ft. Huachuca, Arizona. The analytical segment of the RPAODS program was conducted in-house at ECOM and by contract.

During this same time frame, Army Materiel Command (AMC) Land Warfare Laboratories (LWL) developed an RPV as an extension of a materials development program. In conjunction with the Electronics Warfare Laboratories (EWL), LWL conducted a small program to determine if a mini-RPV could be used to carry a communications jammer. This program expended its funds before a successful demonstration could be completed. The U.S. Army Missile Command (MICOM) was conducting in-house investigations of a mini-RPV capable of carrying a 10 pound warhead,—a TV camera,—to be visually guided into a high value target from the ground. This program was designated Kamikaze.

All these programs eventually became the management responsibility of the RPV Weapons System Manager at USAAVSCOM. During coordination with TRADOC, a need appeared for a system to provide real time surveillance and target acquisition. However, not enough information was available to establish mini-RPV requirements. It was decided in joint meetings between AMC and TRADOC that a mini-RPV system using off-the-shelf technology (as opposed to off-the-shelf hardware) should be provided to the user to allow experimentation with current technology. In addition, organizational and operational concepts with the system would be developed in the field during experimentation.

The first major project was the conversion of objectives and guidelines into an operational program. It was determined that USAAVSCOM would procure a limited number of mini-RPVs and ground control stations in five staggered phases in order to perform a series of technological and operational demonstrations. This program was christened Little "r".

The following requirements were identified as essential to the Little "r" Program:

- Low cost
- Daylight TV (real time imagery)
- Detection and map location of targets for artillery
- 10–15 KM beyond the FEBA
- Zero launch
- Rough terrain recovery
- Easy transportability
- Man out of the loop as much as possible.

TRADOC responded rapidly to the program and established an RPV point-of-contact at TRADOC headquarters; a TRADOC RPV Steering Committee chaired by Brig. Gen. Morris Brady, Deputy Commander of the Combined Army Concept Development Activity (CACDA) at Ft. Leavenworth, Kansas; and an RPV Task Force at the Artillery School, Ft. Sill, Oklahoma. The latter is designated as the proponent for Little "r" and tasked to develop and execute the testing requirements.

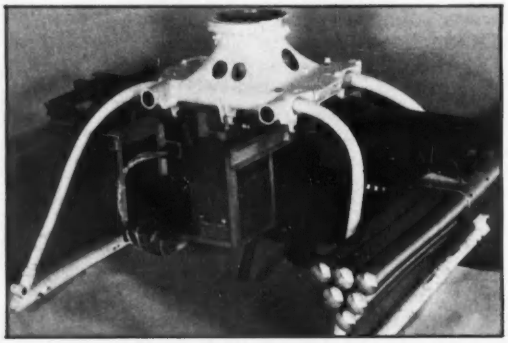
The Little "r" is a five phase program beginning with a simple mission scenario progressing to the more complex. Thirty identical airframes will be utilized in all phases with interchangeable sensors.

The first phase is that of simple surveillance and consists of 10 airframes with a strapped-down TV, single field of view, capable of being slewed from the ground in azimuth, 60 degrees from center and from +10 to −90 degrees in depression.

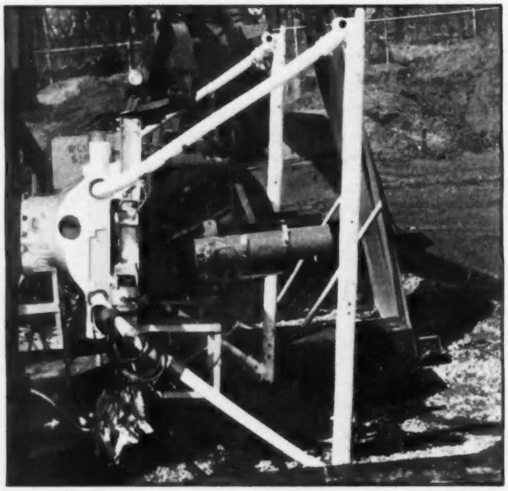
The second phase will consist of five airframes with the same type TV camera as well as a panoramic scan camera to demonstrate photographic capability compatible with the Army Photogrametric Processing System (APPS).

The third phase will consist of five airframes, but the video sensor in this phase will employ a stabilized TV camera with a narrow and wide field of view and an autotracker. This phase will provide better resolution of the target area. The autotracker will allow the RPV to maintain a loiter pattern (figure eight or racetrack) and the TV will be automatically locked on the target.

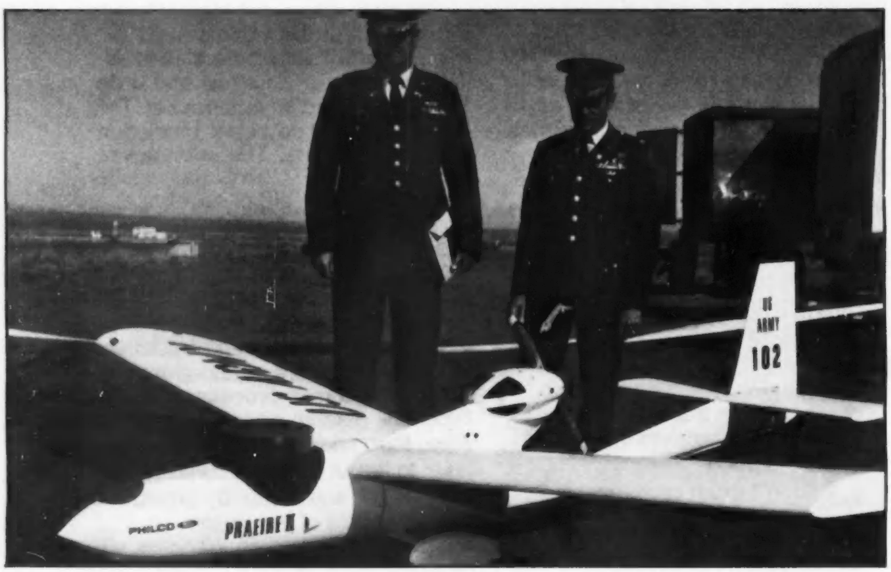
The fourth phase consists of five airframes with the same type of sensors as in phase three, plus a laser ranger. The ground tracking station will also be modified by the addition of a mini-processor. The latter will resolve all real-time target data, then compute the range from laser to target and the position of the RPV. It will subsequently provide a digital readout of the target coordinates. These coordinates will be transmitted as a fire mission, and



The Army is testing a variety of remotely piloted vehicles and drones. Some drones have complex subsystems such as rocket launchers (left) and camera mounts (left center).



Included in the Army's program of remotely piloted vehicles is the Praeire II, below. An RPV is an unmanned aerial vehicle controlled from the ground through an electronic data link.



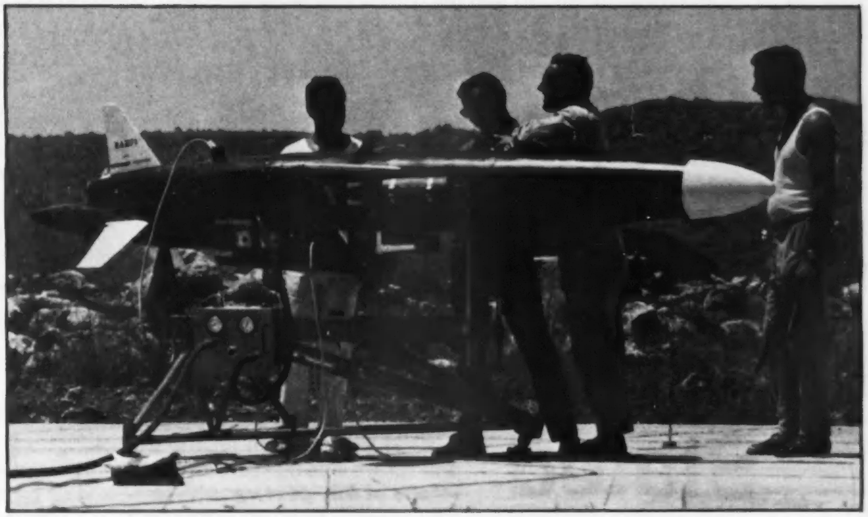
adjustment of conventional artillery fire will be conducted through the RPV.

The fifth phase will consist of five more airframes with the same equipment as phase four plus a laser designator to provide a designation capability for laser guided weapons.

The RPV to be used for all the phases will weigh no more than 120 pounds, fly at speeds between 75 and 120 knots and at an operational altitude of approximately 2000 feet. The first RPV for phase one will be delivered 10 months following the contract award. The contractor will have two months to deliver the remaining nine. AMC will test the initial RPVs for approximately two months and then observe TRADOC's experimentation. Four months have been allocated for this phase. The other RPVs will be delivered at two month intervals and the same procedure followed. The fourth and fifth phases will only require one month of AMC testing.

The RPVs will be flown by TRADOC personnel (E–4, E–5 and above) to demonstrate that the system is compatible with the troops in the field. Maintenance and technical support will be provided by the contractor, and training of the user personnel will be conducted at the contractor's facility. Requirements will be determined, specifications narrowed, cost and operational effectiveness analysis (COEA) performed during and after this test period, resulting in an ROC jointly prepared by TRADOC and AMC. Following the approval of

Northrop Corporation employees adjust a radio-controlled drone at the Namfi Firing Range, Crete. The technicans worked with members of the 32d Air Defense Command during missile firings at the range.



the ROC, a new RFP will be issued for the requirement to field an RPV system for deployment following the standard acquisition cycle.

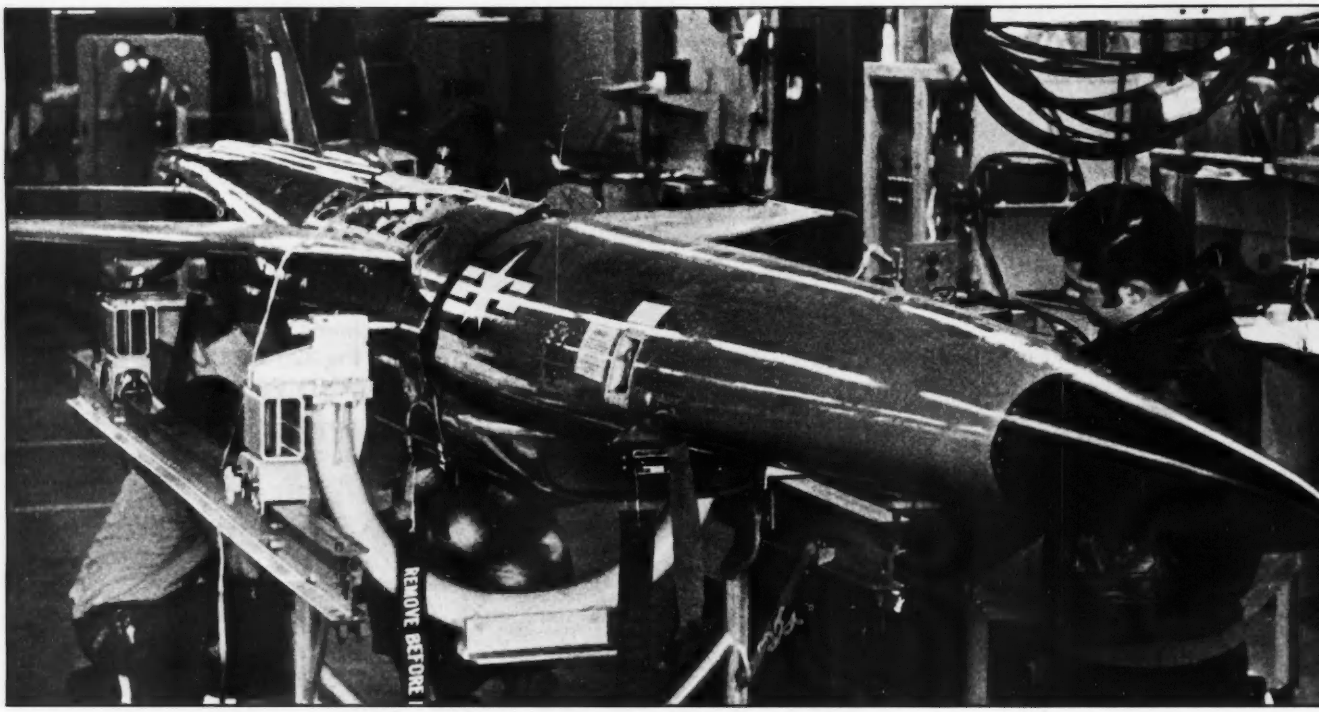
Significant additional responsibility has been given to the systems manager. In addition to the Little "r" program, the MICOM-RPV program, Kamikaze, will also be funded by the USAAVSCOM Weapons System Manager (WSM). This program will demonstrate guiding the RPV into a target with a one to two meter circular error probability (CEP). In addition, methods will be investigated that will allow control of the RPV if it goes beyond the line-of-sight of the tracking ground station.

The RPAODS Program will continue during FY 75 and be used to establish the basis for the TRADOC testing of the Little "r" Program. Testing will be accomplished using contractor flight tests of RPAODS RPVs.

A separate technology program is being established by the WSM to investigate areas such as secure data links, small engine (5–50 horsepower) technology, low cost navigation systems, multi-control of RPVs (controlling more than one RPV from a single ground station), low light level TV, forward-looking infrared, and survivability and vulnerability. These are fields to be investigated to insure improvement in RPV capability.

The Little "r" Program was developed with the philosphy of success dependency. Movement from one phase to another is dependent upon results from the previous phase. Another guideline was the Army Materiel Acquisition Review Committee (AMARC) proposal which recommended avoiding the "development of a ROC" until prototype hardware has demonstrated required performance capabilities. Thus, the Army RPV program is a milestone effort incorporating new management approaches with a new weapon system. The potential of the mini-RPV has attracted a great deal of attention at AMC, Department of the Army and DoD.

Finally, what does the future hold for RPVs? Two major areas should be addressed: civilian and military. In the civilian market, potential uses include traffic spotting and control, employment in natural disasters, observation of forest fires, and law enforcement surveillance. On the military side, the impact may be staggering with such possibilities as families of mini-RPV Kamikaze combinations in a "mother-daughters mode", anti-helicopter weapons, continuous surveillance for units moving toward the FEBA, damage assessment, cover and concealment analysis, and electronic counter and counter-counter measures. The present Army RPV program represents the first planned step to development and employment of what may prove to be one of the Army's greatest assets.



RPVs Slated For Fleet Duty By 1980s

The U.S. Navy has become progressively more interested in the role that remotely piloted vehicles (RPVs) can perform for the present and future fleet forces. In particular, efforts of this past year have produced definitions of the Navy's needs and an outline of a program to introduce RPVs aboard naval ships during the 1978–1980 time frame.

The Office of Naval Research has conducted various studies on naval use of RPVs and has concluded that there are several major areas in which these vehicles can perform multiple tasks. These studies and Navy requirements have been utilized by the Chief of Naval Operations RPV Coordinating Group to develop courses of action and priorities to provide an operational capability in the near future.

Navy tactical airborne reconnaissance assets provide carrier task forces and amphibious forces with tactical imagery on as near a "real-time" basis as possible. The existing reconnaissance forces are nearing the end of their service lives and must be updated or replaced by the 1978–1980 time period. The program for a follow-on manned aricraft is in the development stage and will result in aircraft on board the carriers in the late 1970's.

To enhance the aircraft carriers' capabilities, it is planned to augment manned aircraft with RPVs equipped with various imaging systems.

Naval amphibious forces depend on carrier-based tactical reconnaissance aircraft to provide the imagery required to conduct their operations. Time losses and the uncertainty of aircraft availability from this 'shared' method of operating have caused amphibious commanders to seek reconnaissance assets integral to their own forces. RPVs can provide

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Navy RPV Program Dates To 1918

Navy technicans at Naval Air Station North Island, California, check a supersonic Firebee II with a flight check console. The Firebee drone is used by Navy ships and aircraft in training exercises.

Navy mission-oriented remotely piloted vehicle (RPV) programs date back to 1918. For various reasons, such as inadequate funding, operational incompatibility, and technical difficulties and deficiencies, these programs were discontinued. In 1918, the Navy had an unmanned aircraft used for Kamikaze-type attacks called the Flying Bomb. The next Navy development was the assault drone, a remotely controlled drone designed to carry ordnance to enemy targets. In the 1950s the F6F Flying Bomb was a carrier-launched aircraft flown with some degree of success into enemy targets. Next was the DASH program from 1959 to 1970. This was a drone antisubmarine helicopter, a QH–50, deployed aboard ASW escort ships for stand-off weapon delivery. The SPRA program utilized a Navy target drone, operating from carriers, to do photo reconnaissance.

Currently, the Naval Ship and Research Center at Carderock, Maryland, is in the process of constructing a test vehicle out of off-the-shelf items, equipment and parts from other programs, coupled with the fabrication of certain unique parts of the airframe. Basically, this is a tail-sitter type RPV which will be launched and recovered from a nose hook on the vehicle operating from and to a rig positioned over the side or stern of the ship.

Carderock has recently completed a RPV-ship interface investigation which addresses those unique factors which must be considered in determining the feasibility of utilizing this capability, and efforts are currently underway to determine the best manner in which to launch and recover a vehicle from ships in this type of task force.

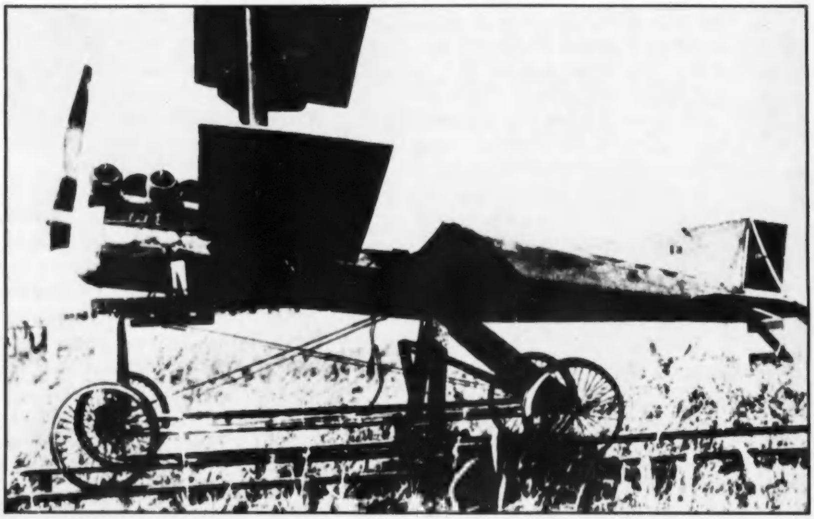
The LCC (command ship), LPH (helo carrier), and smaller amphibious ships are considered candidates to carry RPVs. If one considers the size of RPVs as being either "mini," "midi," or "maxi," it is possible to tailor the RPV sensor system for each class of ship. "Maxi" "Midi" RVPs are approximately the size of current target drones and will be capable of greater ranges and larger payloads than the "mini" vehicles. RPVs, of course, are similar in size to the USAF Compass Cope or could evolve into even larger platforms in the future. For amphibious use, the "mini" classes can provide real-time or near-real-time tactical reconnaissance information during all phases of an amphibious landing.

The new sea-control ship is being designed to protect the ever-necessary support forces. Although our airlift capability is exceptionally good, there still is a need to provide surface transportation for a large amount of material to support an advanced-base military operation. To detect threats against these sealift forces and to ensure that the forces reach the forward areas is the goal of the sea-control ship. RPVs with systems for reconnaissance or strike operations very easily can augment the manned aircraft operating from this type of surface vessel.

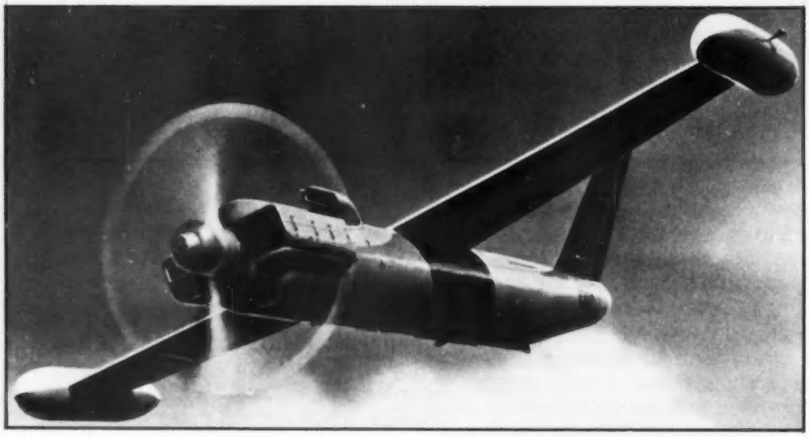
Finally, command and control also must be considered in an overall RPV program. Manned forces have the ability to relay communications, provide airborne early warning, and observe the action of opposing forces. RPVs can be configured with these same capabilities and, through systems such as the NTDS (Navy Tactical Data System), can give the fleet commander additional control of a situation.

Naturally, every program has some associated problems, and the Navy RPV program is no exception. The Navy is unique, though, since it must cope with various types of surface vessels and the elements at sea. For example, the ship configuration determines how much topside space will be available for RPV handling, launch., and recovery. RPV size and type will influence launch and recovery system choice.

In brief, the Navy may be able to utilize RPVs in the following broad areas: carrier and amphibious tactical reconnaissance, ocean surveillance, strike support for all forces, antisubmarine warfare, airborne early warning, and command and control.



The Kettering Bug (right) is typical of the early remotely piloted vehicles available to the Military Services. The Navy program progressed to the KDB–1 remote-controlled target aircraft (below) in 1958. This 600-pound drone was capable of speeds in excess of 300 knots and altitudes of more than 40,000 feet.



Following the Navy's KDB–1 of the late 1950s was the subsonic Firebee (right). The Firebee, built by Teledyne Ryan, has progressed to the newer and more sophisticated Firebee II used as a supersonic drone for ships and aircraft training.

RPVs aboard nonaviation Naval ships. The Naval Weapons Laboratory, Dahlgren, Virginia, is engaged in developing the technology for demonstrating the practicality of deploying a small, low cost and lightweight mini-RPV aboard ship to perform real-time tactical reconnaissance and targeting missions. The primary objectives are to actually demonstrate shipboard launch and automatic recovery, plus communications reliability, and a mission performance capability from Naval nonaviation ships.

The Navy's program objectives include satisfying their operational requirement. This includes providing a multi-mission capability, wherein the same basic vehicle or airframe will be used and by interchanging the modular sensor payload realize various mission capabilities.

The currently established operational requirement for remotely piloted vehicles includes those missions which the RPV is capable of performing in augmentation of manned aircraft. These include: reconnaissance, ocean surveillance, amphibious support operations, defense suppression, a strike mode for interdiction, covert missions, and those missions where the risk for manned aircraft is unacceptably high in a physical or political sense.

To realize the Navy's operational concept and objectives three different types of RPVs are envisioned: a mini-RPV up to approximately 150 pounds, a midi in the 3,000 pound class, and a maxi which will be a large, high altitude, long endurance bird primarily used for ocean surveillance. The Navy's RPVs are planned for threats anticipated in the 1985 time frame.

First priority is the mini-RPV. These will operate primarily from nonaviation ships, support the Marine Corps ashore and in amphibious operations. It is to have a multi-functional capability for additional missions.

Second priority is the midi class. These will be carrier-based or ship-launched system designed to expand the capabilities of the mini.

Third priority is to adapt the maxi-RPV for application in long endurance ocean reconnaissance, surveillance and similar type missions. There are some difficult problems in adapting RPV technology to shipboard use. The most difficult being that of launch and recovery from a ship at sea. Although launch and recovery is a problem in all RPV applications, it is compounded by the at-sea environment.

Command, control, communications (the C^3), as well as over the water navigation, are much more difficult to master at sea. Over land it is possible to use topographic maps, terrain markers, TACAN type navigation, transponders and similar aids.

Aboard ships at sea there is the EMI problem, which is less troublesome ashore. Space limitation is another constraint. Safety—always an extremely important factor in the confined ship-board environment—must be foolproof. Also to be considered is the environmental impact of the RPVs on ships as well as the effect of the corrosive-at-sea environment on the RPV structure. Finally, the problem of a ship's motion in a seaway must be coped with.

The all-weather environment poses another objective which may not be achievable in the near future. Endurance and payloads have some variance but this is not so critical since payload weights and endurance are somewhat interchangeable. The less the payload weighs, the longer the endurance and vice versa.

One aspect of the mini-RPV the Navy would like to stress is the low observables. This is a very big plus factor and one that emphasizes the need for the mini-RPV. The Navy envisions multi-mission capability for RPVs by utilizing interchangeable modular sensors. Some of the missions that might be planned for the mini-RPV include:

- Reconnaissance relay gunfire spotting mission in an amphibious support operation.
- Target designation for over-the-horizon targets.
- In addition to the RPV's ASW capability, it also could be used as a data relay link for passing information from the ASW LAMP helicopter.
- Ocean surveillance, always a problem to nonaviation ships, can be significantly improved through the use of RPVs.

The Navy's RPV program is organized with the Deputy Chief of Naval Operations for Air Warfare, OP 05, as the program sponsor. To bring the views of interested parties together the Navy has established a coordinating group, composed of representatives of the various OPNAV offices, NAVMAT Headquarters, the Naval Systems Commands and the Naval Laboratories. The Program Manager is PMA–247 in the Naval Air Systems Command.

Ongoing programs at the Naval Weapons Laboratory, Dahlgren, are being jointly funded by the Navy and Advanced Research Project Agency (ARPA) this fiscal year. These programs are primarily concerned with shipboard launch and recovery.

The Navy will interface with all the other Services and agencies in pursuit of its RPV program. In the past five years, there has emerged technological advances that offer the Navy the potential to realize a ship-deployed RPV capability. These advances have led to small stabilized imagery sensors for day and night operation, miniaturized laser designators, mini-cameras, improved ground processing, and interactive display modules to manage the RPV and its sensor designated payload.The Navy intends to apply this technology and that to be developed in the future to solve the Navy's unique shipboard problems.

The Role of RPVs In the Air Force

BY
JOHN L. McLUCAS
SECRETARY OF THE AIR FORCE

I would like to review why we in the military are interested in remotely piloted vehicles (RPVs). I see three basic reasons and I think we should constantly keep these in mind when we talk about the future.

First, RPVs can be used to reduce manned aircraft attrition in the very high threat environments. This can be done by assigning the primary role to the RPV as we have done with aerial photography or by utilizing the RPV in a support function to assist manned aircraft in such missions as chaff dispensing.

The *second* reason is to provide an acceptable way to accomplish certain tasks when the mission or area of operation is politically sensitive, and we just don't want an aircraft flight crew exposed or involved.

The *third* reason, and by far the most important for the future, is to achieve a significant cost advantage over comparable manned aircraft systems. Here lies the key to greatly expanded use of RPV. Most of our operational work in the past was based on the high attrition or the political rationale, but now we must more fully exploit the cost advantage aspect as well.

From time to time I am asked, "Is the Air Force really serious about RPVs?" In a nutshell my answer is, "Yes, we are serious!" The reconnaissance role has already been unquestionably established, and we will definitely retain and improve this capability in the future. We have flown over 2,500 combat sorties in Southeast Asia and, in general, the results have been outstanding. Often the small RPV was the only system that could get in under the weather and bring back high-resolution, low-altitude photography of a particular target or area of interest. In the future we would like to get that information much faster, perhaps in real time, so that it can be more responsive to tactical needs.

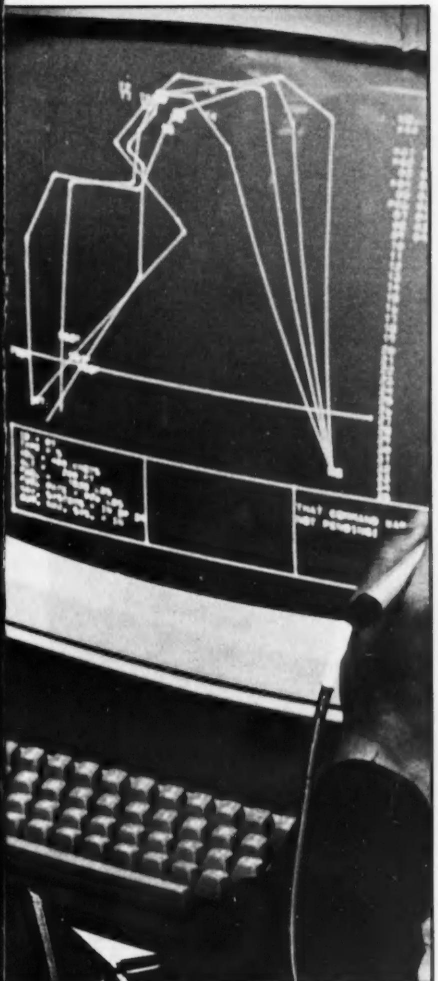
In addition, electronic warfare support for manned aircraft is being expanded. The high-altitude surveillance and communications relay missions are also here to stay, as these are natural and appropriate missions for RPVs.

When we turn to some of the newer areas, however, such as air-to-ground strike or air-to-air combat, our course is not quite so clear. We just don't have enough experience yet to make major commitments. There are fundamental questions about effectiveness, vulnerability, and cost that have yet to be answered. Certainly we don't want to build a large force with an obvious Achilles heel.

I see a series of prototype or interim systems with extensive test and evaluation required as we enter each new mission area. In this way we can build on our past experience and pursue an orderly expansion into new uses for RPVs. Demonstrated operational concepts will pace our future growth because I don't think that technology presents any major barrier.

About two years ago I spoke to the Electronic Industries Association in Washington, D.C. At that time I talked about how RPVs had evolved from target drones and stressed their basic potential for saving lives and money. I then went on to explain that we were shifting our management outlook from simply satisfying immediate operational needs to a more long-range planning perspective—although we were then, and are still today, not quite sure what the best organizational setup is. I also mentioned very briefly the then current use of RPVs in reconnaissance in Southeast Asia, and went on to discuss the possibility for using them in long duration surveillance and as communications relays.

Next I noted that we were encouraged about the prospects for



Air Force SMSgt Elmer Johnson operates an enroute/return operator control console during a simulation study of a remotely piloted vehicle control center. The study is being conducted in the establishment of system design guidelines for future real-world RPV control centers. The work is being conducted by the 6570th Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio.

using RPVs to navigate to a predetermined location, identify, and then accurately strike a target. In this connection, I spoke of the need for a better navigation capability, for improved sensors and data links to provide real-time control, and finally the need for guided munitions such as the Maverick and EO or laser bombs. In closing I mentioned some of the studies that we had underway in our labs and suggested that we needed to move positively but cautiously in exploiting the potential that RPVs have to offer.

Today we are further along toward meeting some of those needs, and we have gained additional experience in improving our RPV operations, for example, in the recovery phase. But in general, I think we are really just beginning to envision the true potential of RPVs, and we still need to overcome many of the same obstacles I mentioned two years ago.

In Southeast Asia at the height of the war, we typically got 10 flights out of a drone before we lost it. In reviewing our experience in Southeast Asia, several major problems stand out. One continuing problem is navigation accuracy. Our reconnaissance missions were flown at very low altitudes to stay below the weather and to provide high-quality photographs. We also found that very-low-level penetration of enemy defenses provided the best suvivability.

However, the lower the vehicle's altitude, the smaller the field of the sensor; so we have a requirement for very accurate navigation. Many targets were missed even when the drone got into the area, returned home, and was successfully recovered, just because the target was outside the field of view of the camera. We've done a lot of work on this problem including LORAN navigation and TV systems on the RPVs to help find the targets, but there is still room for improvement.

Another formidable problem was the difficulty we encountered with drone recovery. We developed a rather complex scheme for mid-air recovery using parachutes and helicopters, and we experienced quite a few failures along the way. Today this system is operating at about a 98 per cent success rate, but it has taken almost eight years to get it there. Many of the losses were operational vehicles carrying valuable reconnaissance data. We just can't afford that kind of learning curve in the future. We are still looking for good new ideas for RPV launch and recovery.

To me the losses due to parachute failure represent an especially pertinent example of our need for more reliable equipment and better testing. In Vietnam we had to put up with these unreliable components because of the exigency of the situation, but now we are no longer involved in an immediate conflict and we have time to do things right.

We can start by overcoming the difficulties we have had in the past in trying to demonstrate new RPVs. It isn't making progress to develop a system which performs well in the air but crashes on landing because of inadequate instrumentation. Similarly, it isn't progress to develop a system which is vulnerable to failure because of the loss of a single component. These failures would be non-permissible in the case of an airplane where you have redundant components. Perhaps some of the same philosophy should be applied here.

I am convinced that we just cannot tolerate this kind of failure in our development programs, and especially in their early phases. I would say that industry must go out of its way to make sure that instrumentation is adequately backed up to prevent such losses. One or two more failures like we have had in the past would be enough to set us back by several years.

I suppose that no interchange between the Department of Defense and industry would be complete without at least some mention of reliability, but this time there is a different twist. Drones do not offer an escape from the demanding requirement for high reliability. I get the feeling some people mistakenly think that all RPVs, being unmanned, are built to be expended, and thus reliability assumes a rather low position in their list of design priorities and requirements. Let me assure you that, in my way of thinking, nothing could be farther from the truth.

One of the clearest lessons which stands out in our drone experience is that acceptance of low reliability in exchange for somewhat lower cost is usually a very poor investment in the long run. If RPVs are to be a truly viable element in our combat forces, they must have functional dependability approaching comparable manned systems. After all, drones do not enjoy the failure compensation provided by an onboard human computer. Even though the man may be in the loop, the man is not in the air, and therefore certain failures will continue to be very unforgiving.

In the Air Force today we have three basic categories of vehicles available to meet the responsibilities assigned to aerospace forces: aircraft, RPVs, and spacecraft. While there are optimum vehicles for some missions, in practice we usually have, and will continue to have, a mix of types performing our various operations. But whether we are protecting the Nation through deterrence or assisting an ally in combat or through logistical support, we should be able to select a particular vehicle category for a particular mission based on the factors of cost, operational effectiveness, and political considerations. Certainly, the selection should not have to be based on the reliability or dependability of the vehicle type.

As just one example, I would like to point to the drones which are being tested in the parallel prototype Compass Cope program and which will require very high reliability to accomplish long endurance flights. There is no doubt that RPVs will be particularly suitable for missions that require electronic payloads to be kept aloft for long periods in a permissive environment, such as tactical surveillance or communications relays. In these cases a drone can potentially stay airborne much longer than an aircraft crew reasonably could, and at a much lower cost. But in these situations the payloads will be so complex and expensive that we simply will not be able to afford losses due to vehicle failures.

As another example, I can foresee missions where drones will fly in close concert with manned aircraft in support roles such as electronic jamming. Of course, there is a question of how you can operate drones and aircraft in the same airspace without interference. Perhaps the way to solve that problem is to get away from the idea of drones and move toward the true RPV with a pilot on the ground who has enough sensors so that he knows exactly where his RPV is and can control it accordingly. For on the one hand you have programmed flight paths and on the other hand you have complete flexibility, where all of the pilot's initiative can be exercised. But in any event we must have reliability compatible with manned systems in order to prevent the obvious interface problems.

So I think it's clear that sufficient reliability is just as important in

A technican inspects the nose-mounted television camera by which the Air Force's Compass Cope pilot sees where he is flying. The pilot is stationary, in a ground-based control booth, and the aircraft is piloted remotely. Compass Cope has a wingspan of 81.2 feet and has flown to 25,500 feet and attained speeds up to 200 miles per hour.

drones as in any other system or vehicle. Obviously, we will not be able to afford the cost of space system reliability, but we must do a lot better than we have in the past. Since the designer of unmanned vehicles is not faced with life support and crew protection requirements, he gains a significant degree of design latitude. I believe that we should take advantage of this design freedom to put more emphasis on basic functional reliability.

All of my comments so far have been directed toward recoverable RPVs—vehicles built to fly many two-way missions. Another concept, and one which we are now carefully evaluating, is a very low cost airframe designed to fly only one sortie. The attractiveness of such an application of drone technology to a truly one-way system depends upon careful cost versus effectiveness trade-offs, and will naturally involve an entirely different formula for computing proper reliability. In some cases perhaps unmodified commercial specifications will be appropriate.

To sum up this discussion of reliability, I believe we will definitely need more dependable RPVs for many of our requirements, and there is still a lot of work to be done in this regard. At the same time, we may well want to develop one-way drones with lower reliability for certain limited uses. In any event, we need to be very careful in assessing drone design and engineering standards, since clearly no single set of criteria will apply to all mission types.

I also want to stress again the importance of realistic testing like that the Air Force is conducting at Dugway Proving Ground in Utah on the BGM-34B strike drone. We believe that such testing is absolutely necessary to assure technical and operational feasibility before we commit large sums of money to specific RPV procurement.

Drone vehicles and missions offer exciting potential. It is difficult to control enthusiasm when thinking about performance unconstrained by human limitations, conservation of human life, and lower rather than higher cost hardware. All of these are glamour selling points for drones.

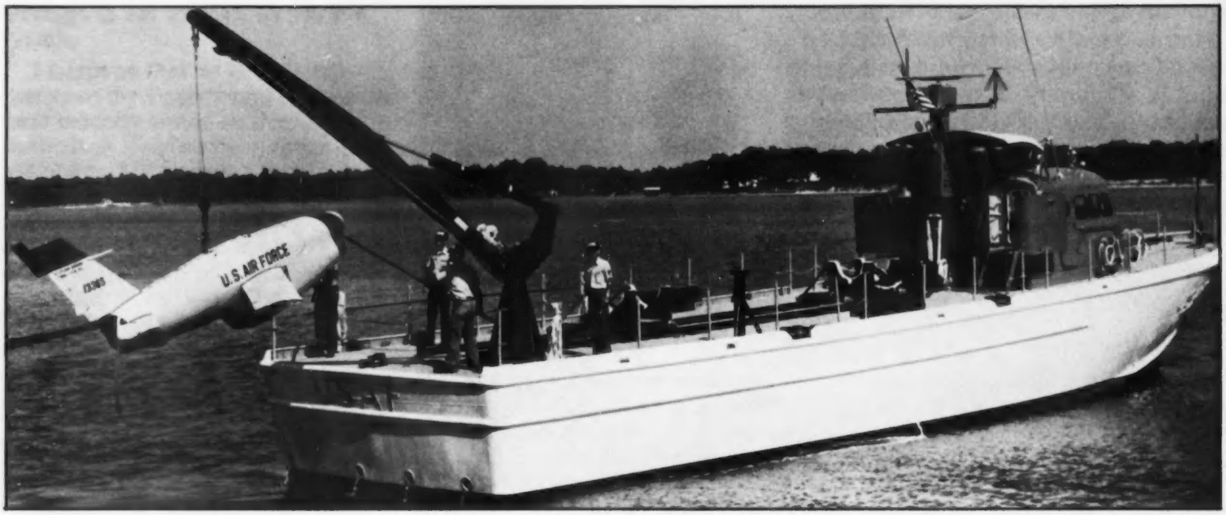
I would like to emphasize, however, that we certainly do not see a "remote" Air Force in the future. Drones and satellites will continue to take on new roles and to make airpower more effective in serving the national interest, but to date we cannot see the end of manned military aircraft, and I doubt that we ever will.

I would also like to point out that while it is important and proper to look at the 1980s and beyond, it is also important that we devote adequate attention to the real world problems of the 1970s. The use of drones will grow only by proving their utility in first one mission and then another, and we have already identified areas worthy of our attention. One of them where industrial innovation is greatly needed is the command and guidance requirement including up-and-down data links.

We are trying to design a single modular system capable of handling all of the missions that we can envision in the future. This will involve secure broad-band links as well as provisions for data retrieval and control of many drones simultaneously. Of course, we also need displays for the pilot-controller and the means to interface with other control systems. I say that we are looking for one multipurpose system simply because I don't think we can afford separate hardware for each of the various drone missions.

Fielding hardware which can do all this will be difficult and will undoubtedly require a major development program. But the success of our efforts in the command and control area will determine to a great extent how far we will be able to go in the future with new RPV concepts.

I know that many people use funding levels as the barometer of real interest in a program. I have said that the Air Force is serious about RPV development and use, but perhaps someone may challenge that statement by pointing to our current funding. In anticipation of that, I would like first to point out that not all of the dollars going into RPV work are readily visible. In each of our laboratories we find numerous projects that are either directly or indirectly associated with RPVs. The sum of these efforts does not show in any of our budget documents. When we look at the non-laboratory work, there is no denying that our current funding for RPVs represents a very small fraction of the Air Force



Air Force "sailors" from Tyndall Air Force Base, Florida, save taxpayers $100,000 as they recover a drone missile from the Gulf of Mexico. The drone was launched as a simulated "invader" target aircraft for training fighter interceptor pilots.

RDT&E budget. The significance, however, is not so much in the dollar level as in the trend. Fiscal Year 1974 represents a low ebb or bottoming out and is largely the result of our switch to normal management. RPV programs have had to compete for funds with all other on-going developments such as the F–15 and B–1.

As you know, we work on a five-year planning cycle so that in theory at least, it takes about five years to properly reflect new things in the DoD budget. We are now just about through that cycle. Now if we look at the trend, we see that RPV Research & Development funding will almost double from FY 74 to FY 75 and out-year planning shows approximately a 50 percent increase each year for several years. This certainly represents a healthy trend and is in keeping with our need to broaden our experience as we go. Remember that this is all planned in the light of tightening DoD budgets and an overall funding squeeze. I certainly don't want to mislead anyone into thinking that the flood gates are about to burst and a huge reservoir of dollars is going to come rushing out, but I do think we will see steady growth.

In conclusion, I would note that the feasibility of using unmanned vehicles in the real world of combat environment has been proven. We have learned a great deal about what RPVs can do and have come a long way toward identifying the actual hardware needs of the future. But many challenges are ahead. For example, we must look to those problems to be met by RPVs operating in a heavy threat environment such as Europe, considering such matters as mixed force operations, multiple control requirements, and enemy countermeasures. It is under such circumstances that the RPV will be put to the ultimate test.

I believe we are entering an era when RPVs will play an increasingly important role in helping airpower serve the Nation. However, we need to check out our missions to make sure that we are preserving the best mix of different types of aircraft, RPVs, and other systems. This is all the more important in an era of extremely tight budgets. Nevertheless, there are significant missions for RPVs to perform and we expect to see them gradually come into their own in the years ahead.

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