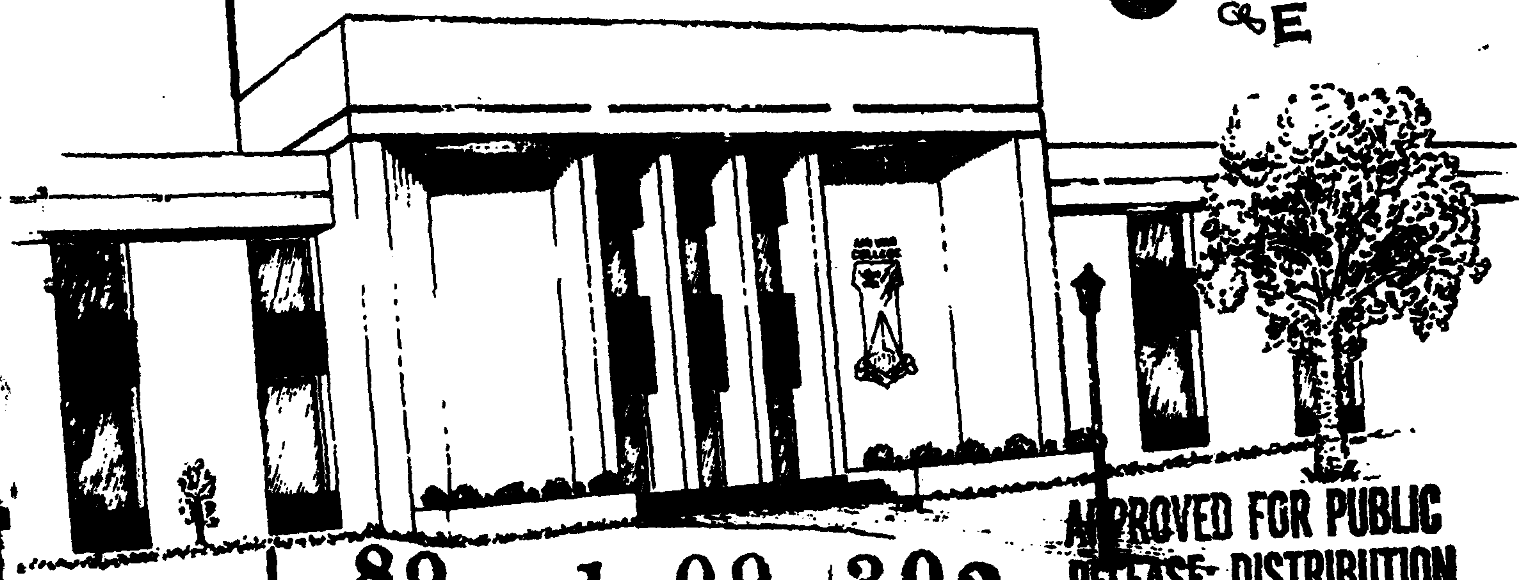
AIR WAR COLLEGE

RESEARCH REPORT

UNMANNED VEHICLES TO SUPPORT THE TACTICAL WAR

LT COL DAVID H. COOKERLY

1988



AIR UNIVERSITY
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AIR WAR COLLEGE
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UNMANNED VEHICLES TO SUPPORT THE TACTICAL WAR

by

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE RESEARCH

REQUIREMENT

Research Advisor: Lieutenant Colonel Rod Payne

MAXWELL AIR FORCE BASE, ALABAMA

MAY 1988

DISCLAIMER

AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: Unmanned Vehicles in Support of the Tactical War

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In 1982, Israel's very successful use of unmanned air vehicles to provide battlefield reconnaissance started an upsurge in the potential inherent in these systems. The author traces the history of unmanned systems in the tactical environment and relates the environmental and technological changes that now make these systems a viable complement to manned air vehicles. This background lays the foundation for a review of current and planned systems and potential missions these unmanned air vehicles can successfully accomplish now and in the future. A summary of concerns and potential problems completes the study.

BIOGRAPHICAL SKETCH

Lieutenant Colonel David H. Cookerly (M.S., University of Oklahoma) has worked with tactical air forces programs for over ten years. His experience covers acquisition, development, testing, operations, and programming. He has experience with unmanned, as well as manned, vehicles, tactical missiles, and command and control. He is a graduate of Armed Forces Staff College and has received the Meritorious Service Medal with three oak leaf clusters and the Joint Commendation Medal. Colonel Cookerly is a graduate of the Air War College, Class of 1988.

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CHAPTER I

INTRODUCTION

Background

In the 1982 Lebanon invasion, Israel pioneered the operational use of a new class of air vehicles. Their Scout and Mastiff drones provided real-time reconnaissance, artillery spotting, electronic intelligence, communications and radar jamming, decoy operations and damage assessment. (4:51) Much of the credit for the Israeli successes in attacking the Syrian air defense batteries without losing or jeopardizing their manned aircraft can be directly attributed to the operational use of their unmanned air vehicles.[1] (4:51)

The United States has used unmanned air vehicles in the past, but overall Defense Department interest waned in the 1970's. (11:25) While our interest in unmanned air vehicles was being shelved, the Israeli mini unmanned air vehicle was coming of age. (12:45) Israel continued development, and the resulting success in Lebanon brought to light new possibilities for these vehicles in support of theater war.

The Soviet Union has substantially increased the capability of their fighting forces. Their doctrine and operational art stresses speed, mobility, and firepower. To this end, they have equipped their forces with new technology systems approaching our capabilities, and in numbers that far surpass what could be considered for defense alone. Their new capabilities, combined with their operational level doctrine, has increased the lethality, speed, and depth of

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[1] For instance, on 9 June 1982 the Israeli Air Force destroyed 17 SA-6 batteries without loss. (4:51)

the potential battlefield. This new battlefield, with sophisticated air defenses increasing the vulnerability of conventional aircraft, has made the use of expensive manned vehicles risky, and opened the door for unmanned air systems to effectively complement our manned systems. (26:72)

Technology advances, threat environment, and cost advantages are all contributing to increased emphasis on the use of an unmanned vehicle. In all areas of the Defense Department, these vehicles are becoming increasingly important because of the new mission flexibility they can deliver. (25:53) In addition, unmanned systems can serve as a force multiplier and provide a mix of expensive and cheap weapons to meet numerically superior enemy forces without breaking the budget.

Purpose

As synopsized above, the unmanned air vehicle can provide a unique enhancement in the future tactical war. Technological advances have made several mission areas ideal arenas for employment of these new vehicles. As will be illustrated, unmanned resources can be effective in the current threat environment, improve our warfighting capability, and release our manned aircraft for other mission work.

In addition to mission effectiveness, unmanned air vehicles can also provide a cost effective solution to our already tight defense budget. Because there is no pilot, the unmanned air vehicle can be procured at significant savings over manned aircraft since life support mechanisms are not required. Likewise, there is also a potential cost and time savings in safety and training requirements required for manned vehicles. The unmanned air vehicle can also be cost effective in another way--the saving of a human resource. With the high threat environment, an unmanned air vehicle can perform certain missions without having to put an expensive aircraft and pilot into jeopardy.

This paper addresses the missions that an unmanned air vehicle can effectively perform, and the changes that have brought the unmanned air vehicle back into the news.

Organization

To address the use of unmanned air vehicles to support the tactical war, this paper first takes a brief look at the history of the unmanned air vehicle and its uses. Secondly, the current environment is defined in terms of threat and technology, and the effect of the environment on the new relevance of the unmanned air vehicle. Next, the paper addresses the missions that unmanned air vehicles can effectively perform now and in the future. Rounding out the paper is a discussion of concerns in the implementation of unmanned air vehicles, and a look at the possibilities of unmanned air vehicles in the future.

The three appendices provide a review of current and developmental unmanned air vehicles. Technical capabilities will be addressed where possible, and intended functional uses will be provided.

Definitions

The literature uses several distinctions in describing the area of unmanned air vehicles. "Drone", "Remotely Piloted Vehicle", "Unmanned Air Vehicle", and "Autonomous Vehicle" are often used descriptions.

Drone has been used extensively in the past to describe vehicles which are guided by preprogrammed instruction. Unfortunately, drone implies a dumb vehicle, and the newer systems are anything but dumb. As a result, the term drone is not used extensively now in the literature. (24:1772) Autonomous vehicle is presently being used to describe unmanned vehicles which do not rely on ground or air operators, and are guided by preprogrammed instruction. (16:30)

Remotely piloted vehicles (RPV) is a generally recognized term for unmanned air vehicles that rely on operator intervention to perform various parts of their mission. (24:1772) Again, however, RPV does not provide a comprehensive term to describe the capabilities inherent in the new systems.

In this paper, the term "Unmanned Air Vehicle" (UAV) will be used. The term applies to all classes of vehicle regardless of the guidance system.[2]

In addition to the vehicles, there are also different types of ground stations. The ground stations are either fixed or portable, and control the aircraft and/or its payload. The ground station is usually composed of three parts: "a control unit comprising a long range transmitter and directing console, to give route and height changes to the vehicle and operate the onboard payload, a tracking system for continuous position plotting, navigation and feeding monitors with target coordinates, and a unit for receiving and processing information from the on-board data link and sensors." (5:70)

Limitations

Several limitations are inherent in this paper and must be identified. The first is the unclassified nature of the paper. Sufficient unclassified material exists to support the purpose of this paper, and the addition of classified

[2] There are three basic types of guidance and payload systems--remotely controlled, programmable, and a combination of both systems. (1:20)

material would not significantly add to the content. Also, the classification of the paper would limit the potential audience.

A second limitation is my restriction in the paper to the discussion of unmanned vehicles in the tactical environment. While the strategic arena has effectively used unmanned air vehicles--ground, sea, and air launched cruise missiles are an excellent example--for many years, the tactical forces have only used unmanned air vehicles in a limited sense. With the new technologies, the tactical forces now have an opportunity to employ complementary unmanned air vehicles to support a wide range of conflict scenarios.

The last limitation is that force structure for unmanned air vehicles is not addressed. The analysis necessary to determine the types and mix of vehicles is a subject unto itself and beyond the scope of this paper.

CHAPTER II

HISTORY

Unmanned air vehicles have been around since the early days of aviation, and military application actually dates from the First World War. (7:23) The first really effective use, however, started in the Second World War. Here we see the application by Germany of the V-1 program where UAVs were used as strike vehicles. The allies also made small scale use of unmanned vehicles to strike heavily defended targets. (4:50)

After World War Two, the world saw tremendous advances in defensive systems and a steady growth in the value placed on a human life. (4:50) Unmanned air vehicles started gaining interest for use as target drones, and as a vehicle that could be used for high risk operational missions, such as photo-reconnaissance. Unmanned vehicles were also used for a variety of other high risk missions, including nuclear sampling. (2:9)

In late 1959, the world was in the midst of a cold war and concerned officers started looking for a potential system, other than the U-2, that could provide photo reconnaissance of enemy territory. The main concern with the U-2 was the conceivable political fallout if a plane was downed over enemy territory. (28:Forward) Within eight months this grim prophecy came true, Francis Gary Powers was shot down over Russia. (28:Forward) President Eisenhower was forced to discontinue U-2 flights, and the United States lost a major capability to see behind the Iron and Bamboo curtains. (28:Forward)

With this incident, and the loss of capability, the search for an unmanned vehicle to provide photo reconnaissance gained impetus. (28:Forward) Looking for a vehicle that could be used as a platform for reconnaissance missions, the

Ryan target drone model was a logical choice, and in the early 1960's the USAF funded development of a reconnaissance derivative, the AQM-34.[1]

This initial development phase was abruptly cancelled, costing a delay of 16 months, and hence, there was no system ready to respond to the Cuban missile crisis. (28:Forward) The crisis, however, once again provided the necessary high level support to put the program back on track, and unmanned air vehicles were ready for service in Southeast Asia, when needed.

In 1964, the Gulf of Tonkin incident increased the United States potential for a major conflict in Southeast Asia, and perhaps, a direct confrontation with China. (4:50) In this area the only source of reconnaissance was the U-2, and the United States expanded the surveillance effort by using an AQM-34 drone detachment. (4:50)

In the Vietnam war, unmanned vehicles made their major tactical debut. Flying primarily reconnaissance missions, these unmanned air vehicles also saw duty as leaflet droppers, electronic intelligence gatherers, and communication relays. (4:50) In all, over 3,000 unmanned air vehicle missions were flown over North Vietnam, Laos, China, and other countries. (28:Forward)

The next documented operational use of unmanned air vehicles in a tactical environment occurred in Korea in the early 1970's. There, the unmanned air vehicles were used to provide low level reconnaissance over North Korea. (4:50)

Although the unmanned air vehicle proved its worthiness in several combat arenas, the United States Air Force had only one RPV unit at the end of the

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[1] The best known target drone--the Ryan Model 124 Firebee I (BQM-34)--first flew in 1951 and the series is still in production. (4:50) This target drone was the considered choice for testing the concept of an unmanned photo reconnaissance vehicle.

Vietnam War, and this unit would not be around for long. (4:51) Tactical planners did not see the applicability of the current unmanned air vehicle in an European scenario because of the threat to the support aircraft, and the less than outstanding mission success rate. (4:51) In addition, in times of shrinking defense dollars, the cost of operating the unmanned air vehicles was prohibitive. (4:51)

The wind down of the tactical drone program did not stop the unmanned vehicle program completely. Although tactical uses were generally put aside, the Air Force did start to emphasize high altitude, long endurance substitutes for the U-2 in the Compass Dwell and Compass Cope programs during the middle and late 1970's.[2] (4:51)

The Israeli success with their drones in the 1982 Lebanon invasion sparked renewed interest in the unmanned air vehicle to support tactical force requirements. Israel had proved that major technological problems had been countered or solved and the unmanned air vehicle could start a new chapter in support of the theater war.

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[2] The Compass Dwell project was to develop an electronic intelligence gathering UAV for use over Eastern Europe. Flights were over 24 hours in duration and at altitudes over 40,000 feet. The Compass Cope project was similar in nature, but aimed for higher and farther (flight times of 24-36 hours and operational altitudes from 50,000-70,000 feet.) (4:51)

CHAPTER III

ENVIRONMENT

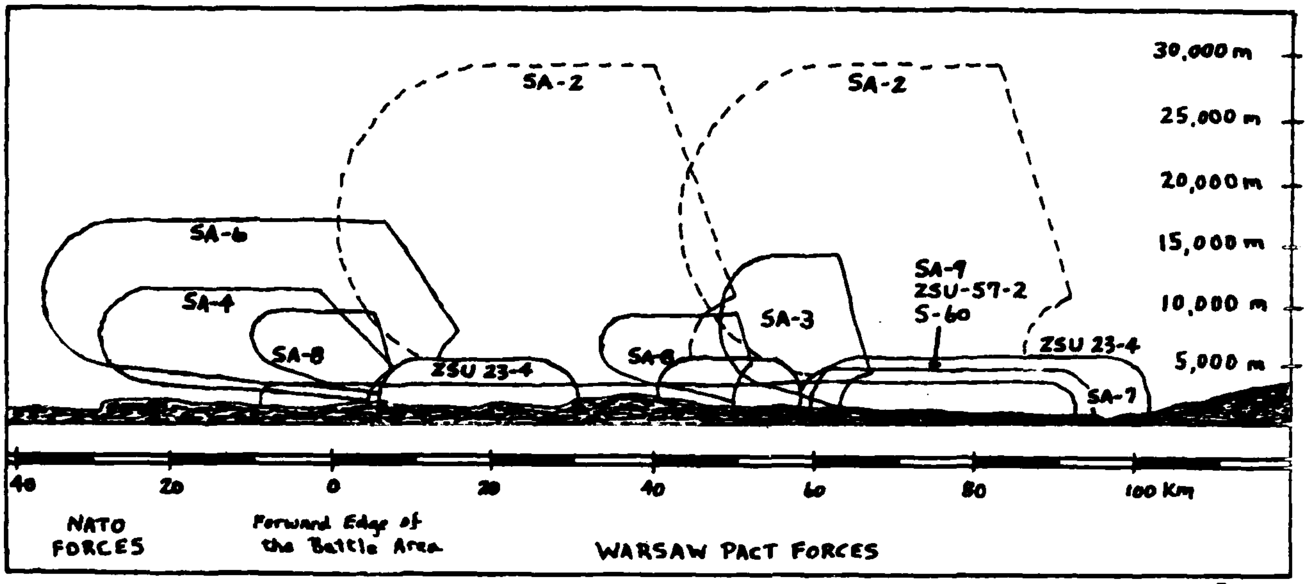
Overview

Unmanned air vehicles to support the tactical conflict have not experienced the emphasis or impetus placed on their development enjoyed by other systems such as manned aircraft. The primary reasons for this lack of emphasis on UAVs was environmental in nature, and based on cost and mission success rates. Although successfully used in Viet Nam, the lack of a particularly hostile threat environment to the supporting aircraft in Viet Nam did not seem applicable to the European theater. (4:51) In addition, the cost of maintaining the supporting aircraft was increasingly burdensome, and the mission success rates were less than outstanding. (4:51) Coupled with the above, the inadequacy of technology to solve basic problems, and the fundamental problem of the relevance of unmanned air vehicles in a primarily manned environment contributed to this lack of research, development, and application.

The environment, however, has changed dramatically, and strategic and doctrinal thinkers are now finding that unmanned air vehicles can satisfy roles and missions better, in some instances, than manned vehicles. Specifically, the threat has increased throughout the spectrum of conflict. Additionally, technology has rapidly advanced the capability that one can put into UAVs to increase their mission and cost effectiveness. Each of these three factors will be addressed.

Threat

The threat environment now facing our forces is formidable indeed. The Soviets, in particular, have developed a highly capable consolidated air defense capability integral to their highly mobile armies, and their fixed command and control, logistics, industrial, and communications locations. (30:10) In the NATO arena, these air defense assets appear in increasingly high numbers and the Soviets continue to enlarge and expand the capability of these weapons. (30:10) The figure below dramatically indicates the depth and breadth of these formidable systems.



30:14

With this advanced, sophisticated system, the Soviets have made manned missions, in very expensive aircraft, increasingly costly. (20:44) Force packages to attack and destroy defended targets require significantly larger numbers of scarce resources. Therefore, selection of targets can be limited by the very number of our resources needed to insure a destruction capability. Added to these resource limitations is the potential cost of the strike itself. If the attrition of our aircraft in the strike is too large to accept, the air commander may have to make the decision that the target is not worth the cost and a valuable enemy resource may go untouched. This situation is especially true in the NATO/Warsaw Pact environment. Is it worth the cost of our manned aircraft--crew and equipment--to destroy heavily defended targets that are substantially less expensive?[1]

The new threat extends beyond the possible NATO/Warsaw Pact battlefield. The advent of relatively low cost and mobile defense systems, such as hand-held surface-to-air missiles, has also added a new dimension to the battlefield. The Soviet experience in Afghanistan attests to the significance of this threat. No matter where we have to fight, it is safe to say that all commanders must be aware of the potential threat, and hence, must plan for this threat, or risk destruction of a valued offensive and defensive capability.

The relatively low cost unmanned vehicle's ability to penetrate heavily defended targets has been proven in the past, and most recently in the 1982 Israeli Lebanon invasion.[2] (1:20) (20:44) Thus, the unmanned vehicle's ability to successfully operate in this increasing hostile environment can provide an alternative to the critical problems of attrition and survivability for forces in the future.

Technology

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[1] An example of this decision process can be seen by looking at the cost involved in attacking a spearhead of tanks and self-propelled artillery supported by armored infantry units. (30:10) Is the loss of an aircraft, such as a F-16, to the defenses, worth the cost of even ten tanks? (30:14) If the loss of the manned asset stopped a potential breakthrough, then one could argue the loss was justifiable. But, with scarce resources, how many such sacrifices can one make until increased attrition takes its toll and no more resources are available?

[2] There are several reasons why the UAV is less vulnerable to enemy defenses. First, the UAV envisioned for the penetration role is much smaller than manned systems and more difficult to locate visually. Also, new composites, smaller vehicle sizes, and smaller engines and exhausts make radar and infrared sighting more difficult. (2:29)

In the past, technology has been an inhibiting factor in keeping unmanned air vehicles on the drawing boards throughout their existence. Weight, volume, power consumption required by on-board systems, and the high cost of the systems one needed in an unmanned air vehicle to accomplish reconnaissance, and other specialized missions, have been the major limiting factors in building and using an unmanned air vehicle. (24:1772) Technological advances in microelectronics, composite materials, optronics, sensors, and micromechanics have opened a new era for unmanned air vehicle mission possibilities. (1:20) These new advances have allowed more comprehensive equipment, at a reduced payload weight, to be placed in the UAV. (27:137) The increased flexibility and survivability provided by expanded sensor capability, data links, and navigation systems has made the use of unmanned air vehicles more feasible than in previous years. (20:45).

In addition to the sensor system capabilities, technology has also aided the basic airframe itself. Small engine advances, lightweight composite materials, and airframe design have made small low cost vehicles possible. (26:75) Thus, when combined with increased sensor and payload capabilities, unmanned air vehicles can become a highly effective force.

Relevance

Cost and mission performance are the predominant factors in the implementation and operation of unmanned air vehicles. While an unmanned air vehicle will probably never replace a manned vehicle for some missions, unmanned air vehicles can do many things extremely well. (7:23) In fact, as Defense and Foreign Affairs editor Michael Dunn states: "because of the small size, tiny radar, acoustical, and infrared signatures, and the like, unmanned aircraft can perform some missions better than manned aircraft. (7:23)

Tactical doctrine is also driving the importance of unmanned air vehicles in future war. The new doctrines being developed under the headings of AirLand Battle and NATO's Follow-On Forces Attack stress deep penetration and attack of second echelon forces. (7:23) Unmanned air vehicles, configured with different payloads, can provide an effective and economical alternative to manned aircraft.[3]

Cost of weapon systems is another area that could stimulate the increased operational use of unmanned air vehicles. The near certainty of defense budget stagnation or reductions could provide the impetus for the acquisition of lower cost alternatives to manned aircraft. (9:22) (20:44) Unmanned air vehicles have the potential to satisfy operational requirements, for a number of different missions, at significantly lower costs. (15:26)

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[3] Examples are close-up reconnaissance, target designation, target attack, of tanks, radars, missile sites, etc., communication relay, decoy, airborne early warning and other similar missions. Combined with their survivability, these unmanned resources can provide a significant increase to our wartime potential. Mission areas are discussed further in Chapter IV.

CHAPTER IV

MISSION POTENTIAL

Overview

We have reviewed the limited, but effective, use of unmanned air vehicles in a variety of situations throughout recent history. We have also examined environmental changes that now appear to make the unmanned air vehicle a desirable, flexible, potentially low cost alternative, that can be used in conjunction with manned aircraft.

There are several advantages to unmanned air vehicles that are common to all the potential mission areas. As stated earlier, the smaller size of the UAV, coupled with a smaller visual, radar, and infrared signature, make the UAV less observable, and thus, allows easier penetration and operation in defended enemy areas. In addition, either preprogrammed guidance or operator guidance using infrared and visual sensors can allow operation in day/night or adverse weather situations.[1]

One obvious limitation on UAV survivability is the potential to be located through its communications. Unless the UAV is operating on its own and not

[1] The ability to operate effectively in adverse weather or night situations is a potential system limitation. The effectiveness of the sensor guidance system and/or the operator is an area that is not yet thoroughly tested nor documented in any of the available literature. One can assume that some capability does exist and would be effective in night or adverse weather (e.g., electronic intelligence gathering) because of the specific mission or operating parameters.

sending data back, there is the potential for the enemy to locate and destroy the UAV by tracing its communications.[2]

The new technologies open a modern chapter in possible uses and situations that an unmanned air vehicle can satisfy. Following is a discussion of likely mission areas.

Reconnaissance

Reconnaissance is a primary mission area that unmanned air vehicles can exploit. High quality information on enemy forces and dispositions is essential in any conflict. (21:12) Currently, our forces lack a key element in our reconnaissance programs supporting the tactical environment. This lack is direct contact between the ground commanders and the air crews and photo interpreters. (20:42) In fact, the Army has a basic requirement for timely and accurate reconnaissance information for the Multiple Launch Rocket System, and is looking at a family of unmanned air vehicles to satisfy its reconnaissance needs. (22:1781)

New developments in technology allow small vehicles to be built that can, with appropriate reconnaissance and surveillance payloads, range the battlefield and penetrate to second echelon areas easier, and with more survivability, than with manned aircraft. The technology necessary to provide this capability is in hand. Israel proved the tactical reconnaissance concept for unmanned vehicles in the Lebanon invasion in 1982 by surveying every Syrian missile site in the Beka'a valley for over a year before the attack. (24:1772)

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[2] There are design capabilities that could be used to limit these deficiencies in communications, such as burst transmissions, but these capabilities are usually costly and could inhibit mission potential.

Not only can the unmanned air vehicle be effective and usable in pre-strike reconnaissance, it can also satisfy the requirement for post-strike intelligence in an efficient and timely manner. Again, this concept has been battle proven by Israel in the 1982 Lebanon invasion. (24:1772)

The major change permitting the development of these reconnaissance capabilities is the rapid growth of microelectronic technology. This new technology has allowed designers to incorporate small, powerful sensors and encrypted data links in an unmanned air vehicle while increasing the vehicles range and endurance.

Unmanned air vehicles can also be effective in long range tactical reconnaissance operations as well as satisfying the shorter range missions. As above, the new technologies permitting small, powerful engines, lightweight airframes, and sensor and data link packages capable of transmitting several hundreds of miles, open up many options for the military strategist and tactician. Use of the unmanned air vehicle in these reconnaissance roles can not only release scarce manned assets for other duty, but perhaps, provide better penetration survivability, and hence, mission success, than the manned systems due to the unmanned vehicles low radar and infrared signature.

Long duration reconnaissance missions are another exploitable area for unmanned air vehicles. In either a penetration or standoff role, the unmanned air vehicle can provide a cost effective alternative to manned systems. (26:74) The long duration mission can probably be more effectively performed by smaller numbers of unmanned systems than with manned systems. Crew and refueling necessities are a limiting factor in regard to manned systems, and usually generate requirements for several systems to be used to provide sufficient coverage. Unmanned air vehicles are not necessarily constrained by these needs. With no crew, no crew exhaustion takes place limiting flight times. (2:34) Also, with no crew, there is no need for life support systems permitting larger mission payloads and more fuel which can directly relate to increased range and endurance.

As a last point, the unmanned air vehicle can be more politically feasible to use in the reconnaissance role since there is no crew to be exploited if the vehicle is shot or forced down. (3:13)(2:39)

Suppression of Enemy Air Defenses (SEAD)/Electronic Warfare (EW)

SEAD and EW are also areas with tremendous potential for unmanned air vehicles. Collection of signals intelligence, jamming, decoy, and threat emitter destruction are all candidates for successful exploitation by UAVs.

As with reconnaissance, unmanned air vehicles can be effectively used to collect threat emitter information. The unmanned air vehicles ability, through its small size and low detection potential when compared to a manned system, to penetrate high threat environments, make them an excellent choice for this role. (26:74) With real time telemetry of collected information we can respond even quicker to changes in the enemy's operating environment with little risk to our expensive manned systems.

If we add a warhead and a homing capability we can then have an effective defense suppression weapon to augment the Wild Weasels. The unmanned vehicle's ability to loiter in a threat environment, vice a manned system, could make a very effective weapon.[3]

[3] The loiter time for a manned system is based on available fuel and the risk of engaging enemy counter air. The unmanned systems loiter time, range, sensor capability, and warhead destruction potential are all interrelated. If you increase sensor or warhead size or weight (payload) then available fuel is decreased, and hence, the range or loiter time is diminished. The UAV loiter time is usually longer than a manned system due to its increased survivability

The unmanned air vehicle can also be configured as a jammer. Effectiveness of the jamming improves as you get closer to the target and operating from the air also improves jamming capability. (26:74) As before, the penetration, survivability, and potential loiter ability improve the mission potential of the unmanned vehicle. Although there are some positive factors associated with using the unmanned air vehicle in the jamming role there is a significant disadvantage. Power requirements to effectively induce jamming are substantial. Currently, it is difficult, if not impossible, to build an unmanned vehicle with sufficient power and loiter time to be effective in any major role, but minor jamming roles are possible. (6:112)

Mini-unmanned air vehicles, configured as decoys can be produced at what should be relatively low cost. Large numbers of these vehicles could saturate enemy defenses causing confusion. (26:74) Israel proved the decoy concept in the Lebanon invasion when they used UAV decoys causing the enemy to launch missiles whereupon they attacked the missile sites with manned resources. (26:74)

Target Destruction

Not only can the unmanned air vehicle be used as a strike vehicle in the defense suppression arena, it has possibilities as a vehicle for destruction of any number of targets, or as a designation platform for guided munitions. Again, the major advantages of the unmanned vehicle to penetrate and survive a

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due to low detection potential. The unmanned system can be destroyed, if found, and the loiter times may be about the same as a manned system in very high threat locations.

hostile environment, due to lower radar and infrared signatures than manned systems, make it a logical choice for a target destruction role.[4]

Technology, transferred from the cruise missile and other programs, makes it possible to build vehicles that could be used for target destruction. The destruction role has several limitations at this time. If preprogrammed, navigation errors inherent in our current systems may not provide the accuracy required for mission effectiveness.[5] (20:45) In addition, if guided by an operator, a communications relay may have to be employed to insure control of the weapon. Thus, the concept becomes more expensive and difficult to deploy, as well as adding more risk, because of the increase in system components. (20:45)

Also, the UAV can be limited by the warhead payload it can carry. Thus, target types may be necessarily limited because of the usual small warhead capacity. While larger UAVs can be manufactured that can carry significant warhead loads, detection of the larger vehicle is easier, and some of the advantages of the UAV are reduced (see footnote 5.)

Where the unmanned air vehicle can have a major impact, though, is in the role of target designation and gunfire adjustment and spotting. (20:48) Laser

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[4] As before, using the unmanned vehicle in this role can also release limited manned resources for other missions such as defensive or offensive counter air.

[5] Although the cruise missile has a demonstrated accuracy requirement, an unmanned vehicle carrying a small, conventional warhead must either be more accurate, or used in greater numbers, to insure destruction of a target than a cruise missile carrying a nuclear warhead. In addition to the accuracy requirement, there is another limitation on the effectiveness of the UAV in a strike role. A manned system can usually carry larger weapon loads than the unmanned air vehicle, as well as being reusable. An unmanned air vehicle large enough to carry similar loads to a manned system would be significantly more detectable, and hence, more susceptible to being countered or destroyed. This limitation should not restrict the use of the UAV since there are many target sets that can effectively destroyed by small precise weapons.

designation is best performed from high angles of incidence. (20:48) These high angles of incidence can be obtained from flying over the target or by standoff orbits at higher altitudes. (20:48) Each of these methods increase the risk for any manned system by multiplying potential vulnerability to enemy defenses.[6][7] Once again, the unmanned vehicle's ability to enter areas where manned vehicles are placed at too much risk makes them a potentially very effective force.

Airborne Early Warning

Unmanned air vehicles can also extend our eyes. Early warning of aircraft, cruise missiles, and other enemy weapons or platforms are all possible with today's technology. (14:115) The unmanned vehicle could provide a low cost source to extend our capability beyond current systems. (26:74) A possible scenario is to utilize unmanned air vehicles as early warning platforms tied to the USAF's E-3A or the Navy's Hawkeye. By placing these unmanned systems over, or close to, enemy territory and using a data link to the E-3A or Hawkeye, we could then station the more costly and mission significant weapon systems in safer locations farther to the rear of the battle area. The unmanned air vehicles would extend our coverage since they could see further into the

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[6] Standoff orbits also create another problem. Target acquisition problems are enlarged due to longer laser paths which "induce spillover of laser energy beyond the target and reducing the accuracy of terminally guided munitions." (20:48)

[7] These orbits also increase the risk to the unmanned vehicle. However, the low radar and infrared signature of the unmanned vehicle, as well as the possibility of using several expendable systems, makes the unmanned vehicle potentially more survivable than the manned system.

enemy's territory, but our command and control aircraft would be safer due to distance from hostile forces.

Communications

As in the case of airborne early warning, the unmanned vehicle can be used effectively to augment communications. (20:48) (26:74) Again, the increased endurance aspects of the unmanned vehicle make it attractive in the relay role. The relay can be configured for most communication functions. The unmanned vehicle can significantly help the ground commander by providing additional flexibility for friendly forces. The ground commander's forces would no longer be tied to communication stations on key terrain locations, e.g., hills, or on a relay aircraft which might be vulnerable to enemy air defenses. (20:48) While an unmanned air vehicle would also be vulnerable to enemy air defenses, the lower detection potential of the unmanned vehicle would reduce the latent risk.

CHAPTER V

CONCERNS

Overview

While the effective use of unmanned vehicles is now entirely plausible, there are areas that must be closely considered before we embark on any major development efforts. This chapter examines the issues that surround the development of unmanned air vehicle capability. In addition to the normal project issues, the chapter concludes with a discussion of two serious concerns that the Air Force must find effective answers to if it is to remain in the forefront of aerospace power. These concerns are not system related, but are policy issues. One is the command and control structure necessary to operate in a conflict with ever increasing numbers of unmanned vehicles saturating the environment. The second issue is that up until now the Air Force is not actively engaged in coordinating the development and use of unmanned vehicles. With the many developments in the services, the Air Force may lose control of its primary air mission by neglecting these unmanned air vehicle developments.

Project Issues

The primary issue surrounding the use of unmanned air vehicles is cost. While much of the literature touts the comparative advantage of unmanned air vehicles to manned aircraft, there are other costs associated with the UAV that must be considered in any decision process. On the surface, the unit cost of an unmanned air vehicle is relatively small when compared to a manned vehicle, but unit cost does not tell the whole story.[1] In fact, the cost of sensors and ground equipment account for over 75 per cent of the total cost. (9:22) The cost of the necessary control systems, the cost in personnel for operation and maintenance, and the cost of technology must be factors for consideration. As unmanned vehicles become more sophisticated, the cost goes up. (26:75) Additionally, the costs quoted by developers tend to be optimistic, and actual costs rise as the system nears deployment. (26:75) Because the unmanned air vehicle is not manned, leading to use in more risky operations, as well as the growing use of expendable vehicles, the attrition rate is a major cost factor. One can assume that the unmanned air vehicle will have a higher attrition rate than a manned system since they will be used in expendable roles and in areas of high enemy threats. Thus, a realistic loss rate and replacement rate must be part of the analysis when total system cost is figured. (2:6) An additional major cost item, indirectly related to the unmanned air vehicle, is the system that will process the data the unmanned vehicle sends back. The systems currently processing intelligence for the commander are complex and thus costly to develop and maintain. Adding the input data from a myriad of unmanned vehicles will not be an easy, nor cheap, task to develop. (10:22) A final expense item is the cost of losing sophisticated equipment to the enemy. This cost is not only in dollars, but in the potential costs of technology transfer,

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[1] As an example the unit cost of the tactical air-launched decoy (TALD) being bought by the Navy was $30,500 (initial 1,000 produced). Compared to an F-14 or F-18 the unit cost is relatively small. This example concerns an unmanned air vehicle on the low end of the scale. Larger and more capable unmanned air vehicles cost more. (9:23) A counter example showing that the cost of an unmanned system can approach a manned system is the story of the Aquila. Research and development is estimated at $850 million putting it in the same ballpark as the F-20, and procurement costs have been held at $969 million only by the Army cutting its requirements. (4:52)

failure of operational plans and procedures, and the enemy's use of the system against us.

Considering the above cost elements, the unmanned air vehicle may not be the cost effective answer to all situations. While the total cost of the unmanned vehicle will probably be smaller than that of a manned system, the bottom line should not be expense alone, but the combat effectiveness. (26:75)

The second project related issue is technology. The effectiveness of an unmanned air vehicle is directly related to technology. Precise navigation is necessary for reconnaissance. (4:51) Structural components must be engineered for low radar and infra-red signatures to increase survivability. (1:21) An effective Identification Friend or Foe (IFF) system must be employed to aid recovery or action by our own defenses. (24:1777) Jam resistent communications are necessary to provide information transfer. (5:74) The area of jam resistant communications is perhaps the most vulnerable point of attack for a potential enemy. Because the unmanned air vehicle will be operating close to enemy forces, in comparison to our forces, it is susceptible to enemy counter measures. (8:43) The system then becomes a part of the duel of counter measures and counter-counter measures. While a determined enemy can jam the data links, we do have the technology that can provide a moderate degree of protection. (8:43)

While the above technologies have been demonstrated and are currently in existence, there is still risk associated with any implementation. Any failure for a system to perform to the specified requirement could negate mission effectiveness, and hence, the ultimate effectiveness of the unmanned air vehicle to support our combat forces.

The next area of project concern is information integration. The multitude of different unmanned air vehicles with their multitude of information gathering systems has a tremendous impact on information processing. Added to this problem is the integration of many different data links and communications systems. (12:46) Our current tactical command, control, and intelligence system(s) has been undergoing similar problems for years. Adding this new burden could overload the system and keep vital information from the people who need it--the battlefield commanders. (20:42) This issue is probably the most complex, and the hardest to solve. It must be solved, however, if unmanned air vehicles are to be effective in a combat situation.

The final project related issue is inertia. While cost, technology, and information integration remain problems, the largest obstacle to utilizing unmanned air vehicles is institutional. (26:72) In 1981, the General Accounting Office (GAO) alleged inefficient management in the Pentagon in failing to field new vehicles. (11:25) The GAO noted several explanations for the inertia: many people are unfamiliar with the technology, that unmanned air vehicles are unexciting compared to manned vehicles, the limited defense budget, and user reluctance--the pro-pilot bias. A way around the inertia is to foster the complementing aspects of the unmanned air vehicle. UAVs are not going to get rid of manned aircraft and manned missions. They can, however, perform complementary missions and missions too dangerous for manned systems, releasing the manned systems for other purposes. In other words, the unmanned air vehicle can be a force multiplier.

Policy Issues

The two policy issues that are central to the effective use of unmanned air vehicles must be solved now if we are to effectively use our current assets to their ultimate. Neither of these issues has been addressed in the literature available to the author. However, the author considers these issues as having the most risk producing potential.

The first policy issue is the command and control structure of the aerospace environment. The technology issue of information integration is part of this policy issue and has been addressed above. The central questions of the policy problem are simply; who is going to control unmanned air vehicles and how is coordination going to be accomplished? The questions must also be addressed from a joint aspect and a coalition aspect. The joint aspect will be discussed first. From the list of systems at the appendices one can determine that a multitude of vehicles will be a part of any conflict. With each service having multiple types of unmanned air vehicles fulfilling multiple mission roles, who is going to assign targets and who will be responsible for deconfliction? The assignment and deconfliction problem extends to attack planning and real-time control. If command and control lines of communication and organization are not clear, we can postulate confusion, misuse of resources, and the potential loss of valuable aircraft--manned and unmanned--to being in the wrong place at the wrong time. Second, even if there is a strong command and control structure, how are we going to coordinate the mass of vehicles? Our current systems are still being developed and modified by procedures to handle the current load. Any additional tasking would undoubtedly saturate the system with a subsequent loss of mission effectiveness.

Moving from the joint world to the coalition environment, the situation grows even more menacing. The same problems are inherent in the coalition environment as the joint environment except that the problems are compounded by the increase in numbers and types of systems. The command and control structure is compounded by national and combined assets, while the coordination aspect is made even tougher due to the numbers of systems involved. As in the joint environment, effective use of any of our resources is contingent upon solving this fundamental policy issue.

The second and final policy issue is directly correlated with the basic doctrine of the Air Force. Where does the Air Force want to be in the control process of air assets? The fundamental premise of the Air Force since World War II is that air assets must be centrally controlled under a single air commander to allow the most effective use of critical resources. To date, each service is developing their own systems, under their own command and control, to accomplish missions theoretically under Air Force purview. While the Air Force is coordinating weekly with the other services as it develops its own unmanned systems, it is not actively undertaking its recognized aerospace leadership role. (9:22) If the Air Force does not address where it stands on unmanned air vehicles and control of the aerospace environment, it will lose control of major mission areas by default. The other services will pass the Air Force by in their quest to improve their combat capability.

CHAPTER VI

FUTURE

The future of the unmanned vehicle can not be precisely determined. The technology is there to support a multitude of missions, but there must be an effort on the part of the users to develop tactics and missions which take advantage of the capabilities that can be designed, and for developers to build systems which live up to expectations. (26:75) "The road to unmanned air vehicle success is already littered with programs which were cancelled or failed to live up to expectations." (26:75)

The United States and its allies are responding with a myriad of programs that will use unmanned vehicles, and the potential for future vehicles to support a multitude of missions is just around the corner. The Air Force has shifted its attitude toward unmanned vehicles to some extent, but it must continue its effort, or it will lose control of the aerospace environment. (17:17) Only time will tell how the Air Force will step up to its ultimate responsibility.

As technology moves forward increasing the speed, complexity, and flexibility of the unmanned air vehicle, the system will be asked to accomplish even more of a mission load. (24:1776) But, unmanned air vehicles should never be used in isolation. The unmanned vehicle is one part of a total force on land, sea, or in the air and must be a consolidated component of a battle plan. (5:79) While the system will have tremendous capability, it will be a long time, if ever, when an unmanned system can replace a manned system for decision making, judgement, and flexibility.

A final reminder of what is in the future for unmanned air vehicles can be summed up with a look at current Soviet literature, which is increasingly mentioning the potential payoff of unmanned vehicles for "their low reflection surfaces, low level of infrared emissions, and their relatively low cost when you consider their value as electronic jammers to screen a salvo of friendly missiles, as decoy targets and even to tow equipment simulating the radar and infrared signatures of ships." (28:Forward) Even if we are not using them we will have to counter them.

By utilizing the unmanned vehicle in roles that it can effectively perform, we not only increase our own warfighting capability, but make our potential enemy's offense and defense more complex and expensive.

APPENDIX A

UAVs--UNITED STATES

This appendix addresses unmanned air vehicles in production or development by the United States. It does not provide detail on unmanned air vehicles that are used as targets although these target vehicles could possibly be engineered for other missions. There are approximately 24 types or series of target UAVs. A description of most target UAVs can be found in Jane's: All the World's Aircraft 1986-1987 or Jane's: Weapon Systems. (31:809-855) (32:356-379)

Brave-200:[1]

Company: Boeing Military Airplane Company

Length: 2.12 m (31:842)

Wingspan: 2.56 m (32:378)

Weight: 120 kg

Propulsion System: 28 hp, 2-cylinder with a four blade pusher propeller

Range: 640 km depending on payload

Cruising speed: 140 mph (loiter at 90 mph) (17:85)

Endurance: 5-8 h (depends on distance to target) (17:85)

Operating/Penetration Altitude: Up to 3500 m

Payload: 50 kg including fuel

Potential missions: Reconnaissance, target acquisition, air attack

Other characteristics: The Brave-200 was built as an expendable system. Fifteen units can be launched by two men from a standard 20 ft container. The West German Army intends to buy 3000 for suppression/destruction of Warsaw Pact forces' radar guided air defense systems.

[1] Unless otherwise noted, the information on this UAV is found in 1:21.

Brave-3000:[2]

Company: Boeing Military Airplane Company

Length: 3.44 m (31:842)

Wingspan: 2.26 m (31:842)

Weight: Total unknown (fuel max: 56.7 kg) (31:842)

Propulsion System: NPT-171 turbojet (Noel Penny Turbines - Britain)

Range: 499 km (56.7 kg fuel and 74.8 kg payload at 10,000 ft) (31:842)

Cruising Speed: Maximum of 700 km/h

Endurance: Unknown

Operating/Penetration Altitude: 7600 m maximum altitude

Payload: min: 74.8 kg/max: 115.6 kg (31:842)

Potential missions: air attack

Other characteristics: The Brave-3000 is launched from a container that serves for storage and transport. Flight control is from an on-board autopilot and central electronics module. Low cost manufacture was a special emphasis of this model.

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[2] Unless otherwise noted, the information on this UAV is found in 1:21.

Aquila:[3]

Company: Lockheed Missiles and Space Company, Inc.

Length: 2 m (32:376)

Wingspan: 3.89 m (32:376)

Weight: 125 kg

Propulsion System: 26 hp, two-cylinder engine with a two blade wooden pusher propeller (5:76)

Range: 600 km

Cruising Speed: 80 to 200 km/h

Endurance: 3 h

Operating/Penetration Altitude: 3600 m (32:376)

Payload: 16.3 kg (32:376)

Potential missions: Target acquisition/designation

Other characteristics: As a target designation system, the Aquila will be used with laser guided munitions such as the AGM-114A Hellfire and ground to ground munitions such as the Copperhead. The United States Army expects to purchase 376 units with 53 ground stations. The Aquila has a low radar signature design and utilizes a fuel saving/payload enhancing net retrieval system designed by Dornier. The Aquila has experienced testing problems, especially with the jam-proof data-link. Its reliability is 92% based on testing missions and scored direct hits on 60 stationary targets and 31 moving targets with the Copperhead fired from ranges between 15 and 20 km.

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[3] Unless otherwise noted, the information on this UAV is found in 1:26.

Skyeye:[4]

Company: Developmental Sciences, Inc. (A division of Lear Siegler, Inc.)

Length: 3.72 m (31:848)

Wingspan: 5.36 m (31:848)

Weight: 235 kg

Propulsion System: 38 hp, two-cylinder engine with a pusher propeller

Range: Determined by payload/fuel mix

Cruising Speed: Max speed of 252 km/h (31:848)

Endurance: 8 hours (63 kg payload)

Operating/Penetration Altitude: 15,000 ft/227 kg (31:848)

Payload: 63 kg (max)

Potential missions: Target acquisition, target designation, air attack, reconnaissance, electronic warfare

Other characteristics: In service with the United States Army and Thai armed forces, the Skyeye could be easily modified to a 12 hour endurance with a payload of 68 to 90 kg. In its target acquisition or designation mission it carries a forward looking infrared system with vertical and lateral stabilization providing the operator three fields of vision. Up to four 2.75 inch rockets can be carried on special mountings for air to ground attack and it is possible that an air to air version of the Stinger can be carried. The Skyeye is retrieved using a flare landing on a special skid. (24:1775)

[4] Unless otherwise noted, the information on this UAV is found in 1:26.

AMT-RPV-1:[5]

Company: TracTel Corporation

Length: 2.18 m (31:855)

Wingspan: 3.05 m (31:855)

Weight: 45 lb (empty: 12.7 kg)

Propulsion System: Rear mounted, single piston engine with a two-blade pusher propeller (31:855)

Range: Unknown

Cruising Speed: Unknown

Endurance: 4 h

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Reconnaissance/surveillance

Other characteristics: The AMT-RPV1 carries a standard payload of two infrared video cameras. (31:855) Communications can include an encrypted transmitter and a frequency hopping capability. (31:855)

[5] Unless otherwise noted, the information on this UAV is found in 7:24.

E-90:[6]

Company: E-Systems' Melpar Division

Length: 2.31 m

Wingspan: 3.04 m

Weight: 40.8 kg

Propulsion System: 13 hp, two cycle, two cylinder engine

Range: 338 km

Cruising Speed: 177 km/h

Endurance: 3 h

Operating/Penetration Altitude: unknown

Payload: 9 kg

Potential missions: varietal

Other characteristics: The E-90 is designed for light payload, expendable missions. Melpar is currently concentrating on payload development with other manufacturers.

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[6] Unless otherwise noted, the information on this UAV is found in 32:376.

E-175:[7]

Company: E-Systems' Melpar Division

Length: 2.52 m

Wingspan: 3.65 m

Weight: 79.3 kg

Propulsion System: 18 hp, two cylinder engine with a two blade pusher propeller

Range: 482 km

Cruising Speed: 193 km/h

Endurance: 4 h

Operating/Penetration Altitude: Unknown

Payload: 18.1 kg

Potential missions: Varietal

Other characteristics: The E-175 is an upgraded version of the discontinued E-130 model. The potential missions include strike and electronic warfare. Melpar is currently concentrating on payload development with other manufacturers.

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[7] Unless otherwise noted, the information on this UAV is found in 32:376.

E-260:[8]

Company: E-Systems' Melpar Division

Length: 3.23 m

Wingspan: 4.42 m

Weight: 118 kg

Propulsion System: 25 hp, two cylinder engine with a two blade propeller

Range: 483 km

Cruising Speed: 161 km/h

Endurance: 5-6 h

Operating/Penetration Altitude: Unknown

Payload: 22.7 kg

Potential missions: Varietal

Other characteristics: A primary mission for the E-260 is reconnaissance. The E-260 can be fitted with several interchangeable nosecones containing a variety of different equipment.

[8] Unless otherwise noted, the information on this UAV is found in 32:844.

E-310:[9]

Company: E-Systems' Melpar Division

Length: 3.77 m

Wingspan: 4.30 m

Weight: 141 kg

Propulsion System: 25 hp piston engine

Range: 180 km (max)

Cruising Speed: 125 km/h

Endurance: 5 h

Operating/Penetration Altitude: Unknown

Payload: 27 kg

Potential missions: Varietal

Other characteristics: The E-310 is designed as a cost effective vehicle for low level reconnaissance. It has minimum radar, IR, acoustic, and visual signature.

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[9] Unless otherwise noted, the information on this UAV is found in 32:844.

E410M:[10]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 10.4 kg

Propulsion System: 4 hp, electric motor, 4 fan ducts, each with two blade fan

Range: Unknown

Cruising Speed: Unknown

Endurance: Max hover time indefinite

Operating/Penetration Altitude: 61 m

Payload: 4.5 kg

Potential missions: Surveillance

Other characteristics: VTOL vehicle capable of horizontal and vertical flight.

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[10] Unless otherwise noted, the information on this UAV is found in 31:838.

P115M:[11]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 13.6 kg

Propulsion System: 5 hp, two cylinder piston engine with a two blade fan

Range: 56 km

Cruising Speed: 105 km/h

Endurance: Max hover time 30 min

Operating/Penetration Altitude: 4,575 m

Payload: 4.5 kg

Potential missions: Surveillance

Other characteristics: VTOL vehicle capable of horizontal and vertical flight.

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[11] Unless otherwise noted, the information on this UAV is found in 31:838

R124M:[12]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 91 kg

Propulsion System: 50 hp rotary engine with a seven blade fan

Range: 515 km

Cruising Speed: 282 km/h

Endurance: 1 h 45 min

Operating/Penetration Altitude: 4,575 m

Payload: 20.4 kg

Potential missions: Surveillance

Other characteristics: VTOL vehicle capable of horizontal and vertical flight.

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[12] Unless otherwise noted, the information on this UAV is found in 31:838.

R1242M:[13]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 136 kg

Propulsion System: Twin 50 hp rotary engines

Range: 692 km

Cruising Speed: 402 km/h

Endurance: 1 h 45 min

Operating/Penetration Altitude: 4,575 m

Payload: 56.6 kg

Potential missions: Surveillance

Other characteristics: VTOL vehicle capable of horizontal and vertical flight.

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[13] Unless otherwise noted, the information on this UAV is found in 31:838.

R820M:[14]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 544 kg

Propulsion System: 400 hp rotary engine, eight fan ducts, each with a seven blade fan

Range: 193 km

Cruising Speed: 145 km/h

Endurance: 1 h 15 min

Operating/Penetration Altitude: 4,575 m

Payload: 181 kg

Potential missions: Surveillance

Other characteristics:

VTOL vehicle capable of horizontal and vertical flight.

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[14] Unless otherwise noted, the information on this UAV is found in 31:838.

R8202RM:[15]

Company: Aerobotics Inc.

Length: N/A

Wingspan: N/A

Weight: 907 kg

Propulsion System: Twin 400 hp rotary engines

Range: 257 km

Cruising Speed: 177 km/h

Endurance: 1 h 15 min

Operating/Penetration Altitude: 4,575 m

Payload: 363 kg

Potential missions: Surveillance

Other characteristics: VTOL vehicle capable of horizontal and vertical flight.

---

[15] Unless otherwise noted, the information on this UAV is found in 31:838.

AURA:[16]

Company: AEROMET Inc.

Length: Unknown

Wingspan: Unknown

Weight: 725 kg

Propulsion System: 115 hp Avco Lycoming O-235 with a fixed pitch propeller.

Range: 3,706 km (with max fuel of 197 l)

Cruising Speed: 309 km/h (normal)/204 km/h (economy)

Endurance: 12 h (max)

Operating/Penetration Altitude: 6,100 m (max)

Payload: 181 kg

Potential missions: Reconnaissance

Other characteristics: The AURA was developed for test ranges where a manned aircraft is unsuitable. It can also be flown in a manned configuration.

[16] Unless otherwise noted, the information on this UAV is found in 31:838.

Raider:[17]

Company: Beechcraft

Length: 5.13 m

Wingspan: 3 m

Weight: 460 kg (including booster)

Propulsion System: One 3.68 km Ames Industrial built Microturbo TRI 60-2 Model 074 turbojet engine.

Range: Dependent on mission profile

Cruising Speed: 954 km/h (max level)

Endurance: 1 h 12 m (2 h 36 min with aux tanks)

Operating/Penetration Altitude: 12,200 m

Payload: 45.5 kg internal or 159 kg external

Potential missions: Varietal

Other characteristics: Payloads can include radar jammers, flares, chaff, decoy, and future applications include reconnaissance and intelligence gathering. It be operated in a preprogrammed or ground controlled environment.

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[17] Unless otherwise noted, the information on this UAV is found in 31:841.

NV-151:[18]

Company: Northrop

Length: 5.94 m

Wingspan: 3.32 m

Weight: 635 kg

Propulsion System: 4.45 km class turbojet (other engine options available)

Range: 2,223 km (15,240 m altitude)

Cruising Speed: 1,075 km/h (max level)

Endurance: 2 h 35 min (15,240 m altitude)

Operating/Penetration Altitude: 15,240+

Payload: 91 kg

Potential missions: Varietal

Other characteristics: The NV-151 can be launched from land, ship, or air.

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[18] Unless otherwise noted, the information on this UAV is found in 31:850.

PAI Heron 26:[19]

Company: Pacific Aerosystem Inc.

Length: 3.93 m

Wingspan: 6 m

Weight: 150 kg

Propulsion System: One 26 hp Herbrandson D-290 two cylinder engine driving a two blade propeller.

Range: 315 km (max)

Cruising Speed: 195 km/h (max)

Endurance: 10 h (payload of 11.3 kg)

Operating/Penetration Altitude: 6,000 m

Payload: 35 kg

Potential missions: Varietal

Other characteristics: The Heron, using a Mizar avionics package, can independently determine its own geographical position.

[19] Unless otherwise noted, the information on this UAV is found in 31:851.

Partnerships C-1:[20]

Company: Partnerships Limited Inc.

Length: 3.66 m

Wingspan: 4.14 m

Weight: 37 kg (max)

Propulsion System: One 5 hp Quadra Q-50 modified two stroke chain saw engine driving a two blade propeller.

Range: 2,009 km (max fuel)

Cruising Speed: 65 km/h

Endurance: Unknown

Operating/Penetration Altitude: 18,300 m

Payload: 3 kg

Potential missions: Varietal

Other characteristics: The C-1 was designed for high altitude missions.

[20] Unless otherwise noted, the information on this UAV is found in 31:852.

Phalanx MP-9 Dragonflea:[21]

Company: Phalanx Organization

Length: Unknown

Wingspan: 2.74 m

Weight: 1,165 kg

Propulsion System: One 13.34 km turbojet engine

Range: Unknown

Cruising Speed: Mach 0.96 (max level)

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: 270 kg

Potential missions: Varietal

Other characteristics: Unknown

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[21] Unless otherwise noted, the information on this UAV is found in 31:852.

The following UAVs are in the conceptual or early stages of development. Specific performance characteristics are not known, but general missions and characteristics are provided.

Tactical Air Launched Decoy (TALD):[22]

Developed by Brunswick defense, the TALD is envisioned as an expendable decoy or strike vehicle.

Project System 05:[23]

Project System 05 is an Air Force project to provide a high altitude, long endurance vehicle to serve as a satellite surrogate, provide real-time targeting information, and detection of low observable atmospheric targets. Sensor battery endurance is now being developed.

Project System 21:[24]

Project System 21 is an Air Force Project to develop an expendable, low cost, tactical drone for electronic warfare, decoy, reconnaissance, attack, and communications.

Project System 22:[25]

System 22 is an Air Force Program in definition phase. It will provide a family of recoverable vehicles that supplement current systems. Missions

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[22] Unless otherwise noted, the information on this UAV is found in 7:24.

[23] Information on Project System 05 is found in 9:22.

[24] Information on Project System 21 is found in 9:22.

[25] Information on Project System 22 is found in 9:22.

include forward air control, friendly airfield attack assessment, and other high value/cost sensor payloads.

Boeing Experimental UMA:[26]

Boeing Electric Company has developed two prototypes of a very large UAV. Potential missions include reconnaissance/surveillance, communications relay, and border patrol.

[26] Unless otherwise noted, the information on this UAV is found in 31:841.

APPENDIX B

UAVs--NATO COUNTRIES

This appendix addresses unmanned air vehicles in production or development by the NATO countries. It does not provide detail on unmanned air vehicles that are used as targets although these target vehicles could possibly be engineered for other missions. There are approximately 19 types or series of target UAVs. A description of most target UAVs can be found in Jane's: All the World's Aircraft 1986-1987 or Jane's: Weapon Systems 1986-1987. (31:809-855) (32:356-379)

Brevel:[1] (Germany/France)

Company: Messerschmitt-Bolkow-Blohm GmbH (MBB)/SA Matra

Length: Unknown

Wingspan: Unknown

Weight: 100-150 kg (31:819)

Propulsion System: Unknown

Range: 50-80 km (31:819)

Cruising Speed: Unknown

Endurance: 3 h (31:819)

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Surveillance, reconnaissance, and target acquisition

Other characteristics: French/West German system currently being developed. Matra is developing the ground systems while MBB is developing the drone. First systems are projected for 1990-91.

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[1] Unless otherwise noted, the information on this UAV is found in 1:22.

Dornier Mini-drone:[2] (Germany)

Company: Dornier GmbH

Length: 2.25 m

Wingspan: 2 m

Weight: 110 kg

Propulsion System: 26 hp, two cylinder engine

Range: Unknown

Cruising Speed: 250 km/h (max level)

Endurance: 3 h

Operating/Penetration Altitude: 3,000 m

Payload: Unknown

Potential missions: Harassment, EW, and attack

Other characteristics: Unknown

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[2] Unless otherwise noted, the information on this UAV is found in 31:816.

Dornier KZO:[3] (Germany)

Company: Dornier GmbH

Length: Unknown

Wingspan: Unknown

Weight: Unknown

Propulsion System: Unknown

Range: Unknown

Cruising Speed: Unknown

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: All weather day/night surveillance and target designation

Other characteristics: This mini-UAV was developed to compete to satisfy a West German Army requirement. The other competitor is MBB.

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[3] Unless otherwise noted, the information on this UAV is found in 31:816.

MBB KZO:[4] (Germany)

Company: MBB

Length: Unknown

Wingspan: Unknown

Weight: 100-140 kg

Propulsion System: Two cylinder engine driving a two blade pusher propeller

Range: 50-80 km

Cruising Speed: 140-250 km/h

Endurance: 3 h 30 min

Operating/Penetration Altitude: 300-3,000 m

Payload: Unknown

Potential missions: Target acquisition/location

Other characteristics: Unknown

[4] Unless otherwise noted, the information on this UAV is found in 31:818.

TUCAN:[5] (Germany)

Company: MBB

Length: 2.055 m (31:816)

Wingspan: 3.30 m (31:816)

Weight: 100-140 kg (31:816)

Propulsion System: 22 hp, flat twin piston engine

Range: 70 km (31:816)

Cruising Speed: 250 km/h maximum speed

Endurance: 4 h 30 min (max) (31:816)

Operating/Penetration Altitude: 3,000 m (max) (31:816)

Payload: 30-50 kg (31:816)

Potential missions: Target acquisition and tracking

Other characteristics: The TUCAN was an experimental UAV and forms the development basis for the KZO/BREVEL.

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[5] Unless otherwise noted, the information on this UAV is found in 1:24.

Small Anti-Radiation Drone KDAR (KleinDrohne Anti-Radar):[6] (Germany)

Company: MBB

Weight: 1000 kg

Propulsion System: Unknown

Range: Unknown

Cruising Speed: 200 km/h

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Suppression/destruction of air defense systems

Other characteristics: The KDAR is based on the TUCAN experimental program and is in demonstration. The KDAR could be used in conjunction with the F-4G and the Tornado ECR aircraft as well as autonomously. Marconi is the British partner working on the demonstration program.

---

[6] *Unless otherwise noted, the information on this UAV is found in 1:24.*

PAD Anti-Tank Drone (PanzerAbwehrDrohne):[7] (Germany)

Company: MBB

Length: 1.81 m (31:817)

Wingspan: 2.26 m (31:817)

Weight: 150 kg (31:817)

Propulsion System: Unknown

Range: 200 km

Cruising Speed: 140-250 km/h (31:817)

Endurance: Several hours

Operating/Penetration Altitude: Up to 3,000 m (31:817)

Payload: 50 kg (include fuel) (31:817)

Potential missions: Tank attack

Other characteristics: The PAD production model should have a high degree of mobility and autonomy with low vulnerability. It is being designed to be stored as ammunition and be transported on low loaders which would also carry the testing and fueling equipment. Using a predetermined flight profile to a target zone or a patrol of a predetermined line of enemy advance the sensor would identify a target and initiate homing. The system is being designed to neutralize battle-tanks, armored artillery, and air forces on the ground. The PAD complements existing systems by cutting the number of manned missions necessary to neutralize/disrupt 2nd and 3rd echelon forces.

---

[7] Unless otherwise noted, the information on this UAV is found in 1:24.

Firebird:[8] (United Kingdom)

Company: Ferranti Defence Systems Ltd.

Length: 3.40 m

Wingspan: 4.40 m

Weight: 140 kg

Propulsion System: 26 hp, flat twin engine driving a two blade propeller with spinner

Range: 560 km (max)

Cruising Speed: 126 km/h

Endurance: 4 h

Operating/Penetration Altitude: 3,000 m

Payload: 45 kg

Potential missions: Reconnaissance

Other characteristics: Unknown

---

[8] Unless otherwise noted, the information on this UAV is found in 31:829.

Sparrowhawk:[9] (United Kingdom)

Company: AEL (RPV) Ltd

Length: 2.77 m (31:826)

Wingspan: 3.21 m (31:826)

Weight: 60 kg

Propulsion System: 25 hp, flat twin engine driving a two blade propeller

Range: 30 km plus (31:826)

Cruising Speed: 300 km/h (max) (31:826)

Endurance: 1 h

Operating/Penetration Altitude: unknown

Payload: 20 kg (TV and data link)

Potential missions: Target information

Other characteristics: Used by the French Army the Sparrowhawk provides the formation or unit commander with close-in target information. The system is controlled by a three part ground station.

---

[9] Unless otherwise noted, the information on this UAV is found in 5:75.

Phoenix:[10] (United Kingdom)

Company: GEC/Flight Refueling

Length: Unknown

Wingspan: Unknown

Weight: Unknown

Propulsion System: Flat twin, aircooled piston engine (31:831)

Range: 32 km

Cruising Speed: Unknown

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Real time remote target identification and battlefield surveillance.

Other characteristics: The Phoenix comprises a small air vehicle with advance avionics and a GEC Avionics infra red imaging system, an air/ground data link, a mobile ground station and logistics vehicles for launch and recovery. The Phoenix is pneumatically launched and recovered by parachute.

---

[10] Unless otherwise noted, the information on this UAV is found in 5:75.

ASAT:[11] (United Kingdom)

Company: Flight Refueling Group PLC

Weight: 210 kg

Propulsion System: 1.08 kN turbojet engine (31:830)

Range: 25 km (31:830)

Cruising Speed: 275-740 km/h

Endurance: 45 m

Operating/Penetration Altitude: 3,000 m (31:830)

Payload: 15-50 kg

Potential missions: Reconnaissance, decoy, fast target

Other characteristics: The ASAT is a high performance UAV which can be launched under its own power or it can be fitted with JATO booster rockets for zero launch. It can manuever at 6g. The sea variant of the ASAT is the Sea Falconet.

---

[11] Unless otherwise noted, the information on this UAV is found in 5:76.

Sprite:[12] (United Kingdom)

Company: ML Aviation Company Ltd.

Length: N/A

Wingspan: N/A

Weight: 36 kg

Propulsion System: Two Piper P.2/80 flat twin engines driving two counter rotating rotors

Range: 32 km

Cruising Speed: 111 km/h

Endurance: 2 h 30 min

Operating/Penetration Altitude: 250-500 m

Payload: 6 kg

Potential missions: Varietal

Other characteristics: The SPRITE is a private venture. It derives its name from potential missions; surveillance, patrol, intelligence gathering, target designation, and electronic warfare.

---

[12] Unless otherwise noted, the information on this UAV is found in 31:832.

Soarfly:[13] (United Kingdom)

Company: Scicon Ltd.

Characteristics: In early development, Soarfly is to be designed for reconnaissance in a high intensity battle area. It has rotors for a VTOL capability that lock into an x-wing configuration for flight. No other details are known at this time.

[13] Unless otherwise noted, the information on this UAV is found in 31:833.

Tasuma T4:[14] (United Kingdom)

Company: Tasuma (UK) Ltd.

Length: 2.40 m

Wingspan: 2.80 m

Weight: 18 kg

Propulsion System: 3 hp, rear mounted engine driving a two blade pusher propeller

Range: Unknown

Cruising Speed: 110 km/h

Endurance: 2 h

Operating/Penetration Altitude: Unknown

Payload: 10 kg

Potential missions: Surveillance or expendable EW threat destruction

Other characteristics: Can be launched from ground, rail, or catapult.

---

[14] Unless otherwise noted, the information on this UAV is found in 31:834.

Tasuma T5:[15] (United Kingdom)

Company: Tasuma (UK) Ltd.

Length: 2.30 m

Wingspan: 3.30 m

Weight: 22 kg

Propulsion System: 4 hp, pod mounted engine driving a two blade pusher propeller

Range: Unknown

Cruising Speed: 120 km/h

Endurance: 2 h

Operating/Penetration Altitude: Unknown

Payload: 12 kg

Potential missions: Varietal

Other characteristics: Unknown

---

[15] Unless otherwise noted, the information on this UAV is found in 31:834.

Tasuma T7:[16] (United Kingdom)

Company: Tasuma (UK) Ltd.

Length: 3.20 m

Wingspan: 3.60 m

Weight: 42 kg

Propulsion System: One 8 hp engine

Range: Unknown

Cruising Speed: 125 km/h

Endurance: 2-5 h

Operating/Penetration Altitude: Unknown

Payload: 22 kg

Potential missions: Surveillance

Other characteristics: Prototype development of a surveillance UAV.

---

[16] Unless otherwise noted, the information on this UAV is found in 31:834.

CL-89:[17] (Canada)

Company: Canadair Ltd.

Length: 3.73 m (with booster) (31:811)

Wingspan: .94 m (31:811)

Weight: 108 kg (without booster) (31:811)

Propulsion System: 0.56 kN Williams International WR2-6 Turbojet (31:811)

Range: 120 km (31:811)

Cruising Speed: 741 km/h (max) (31:811)

Endurance: Unknown

Operating/Penetration Altitude: 3,050 m (max) (31:811)

Payload: 17-20 kg (31:811)

Potential missions: Surveillance

Other characteristics: The CL-89 is currently in service with the British, German, Italian, and French forces.

---

[17] Unless otherwise noted, the information on this UAV is found in 5:76.

CL-289:[18] (Canada/Germany)

Company: Canadair/Dornier

Length: 4.67 m (with booster) (31:818)

Wingspan: 1.32 m (31:818)

Weight: Unknown

Propulsion System: Single stage turbojet (1000N class) (21:12)

Range: Unknown

Cruising Speed: Unknown

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Reconnaissance, targeting, communications

Other characteristics: The CL-289 is an improved model of the CL-89 which has greater range, speed, and survivability. A solid propellant booster can allow zero length takeoff. (21:12) Recovery is by a two stage parachute system used with air filled landing bags. (21:13) France and Germany have ordered the system.

---

[18] Unless otherwise noted, the information on this UAV is found in 5:76.

Merlin M-100:[19] (United Kingdom)

Company: AVSEC Ltd.

Length: 3.05 m (31:827)

Wingspan: 3.45 m (31:827)

Weight: 25 kg (empty)

Propulsion System: 50 cc twin cylinder gas engine, rear mounted with a shrouded propeller

Range: 250 km (2.5 l fuel) (500 km with extra tanks)

Cruising Speed: 100-175 km/h (stall speed 60 km/h)

Endurance: 2 h with standard fuel tanks

Operating/Penetration Altitude: 250-1,525 m (31:827)

Payload: 10 kg (including fuel)

Potential missions: Varietal

Other characteristics: The Merlin carries a video or infrared camera and a 35 mm camera. Real time pictures are transmitted to the ground station via data link. Six Merlin can be transported in the mobile unit and each can be assembled, checked, and prepared for flight in 15 minutes. The M-100 in four variants (RPM--short range surveillance, RPR--repeater, RPT--training, and RPX--low cost expendable). (31:827)

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[19] Unless otherwise noted, the information on this UAV is found in 5:76.

Merlin M-200:[20] (United Kingdom)

Company: AVSEC Ltd.

Length: 3.05 m (31:827)

Wingspan: 3.45 m (31:827)

Weight: 45 kg (empty)

Propulsion System: 70 cc Horner two cylinder engine driving a two blade propeller

Range: 100-250 km depending on variant (31:827)

Cruising Speed: 95-180 km/h (31:827)

Endurance: 2 h with standard fuel tanks

Operating/Penetration Altitude: 250-1,525 m (31:827)

Payload: 25 kg (including fuel) (31:827)

Potential missions: Varietal

Other characteristics: The M-200 comes in three variants (RPL--long range surveillance, RPR--repeater, and RPS-- medium range surveillance). (31:827)

[20] Unless otherwise noted, the information on this UAV is found in 5:76.

Raven I:[21] (United Kingdom)

Company: Flight Refueling Group PLC

Weight: 15 kg

Propulsion System: 2.5 hp, Webra engine driving a two blade pusher propeller (31:830)

Range: 80 km (31:830)

Cruising Speed: 88 km/h

Endurance: 100 min

Operating/Penetration Altitude: 2,500 m

Payload: 4 kg (31:830)

Potential missions: Reconnaissance, surveillance, radar and communications jamming, and intelligence

Other characteristics: The Raven I, a mini-UAV, is launched from a rail on a small trailer. The ground station is mounted in a Land Rover type vehicle and requires a two man team for operation.

---

[21] Unless otherwise noted, the information on this UAV is found in 5:78.

Raven 2:[22] (United Kingdom)

Company: Flight Refueling Group PLC

Weight: 45 kg

Propulsion System: Unknown

Range: 50 km

Cruising Speed: Unknown

Endurance: 4 h

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Varietal

Other characteristics: The Raven 2 is a development of the Raven 1 with a larger airframe. The Raven 2 can carry a daylight video camera as well as an infra-red camera. The system has a day night capability. (7:40)

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[22] Unless otherwise noted, the information on this UAV is found in 5:78.

TTL JTT-5 Voodoo:[23] (United Kingdom)

Company: Normalair-Garrett/Target Technology

Weight: Unknown

Propulsion System: Normalair-Garrett WAEL 600N gas turbine.

Range: Unknown

Cruising Speed: 480 kp/h

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Varietal

Other characteristics: Unknown

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[23] Unless otherwise noted, the information on this UAV is found in 5:78.

Hawkeye:[24] (United Kingdom)

Company: Target Technology Ltd.

Length: 2.74 m

Wingspan: 2.13 m

Weight: Unknown

Propulsion System: 26 hp, NGL WAM 342 two cylinder engine driving a two blade propeller

Range: 50 km

Cruising Speed: 273 km/h (max level)

Endurance: 2 h

Operating/Penetration Altitude: Unknown

Payload: 15 kg

Potential missions: Surveillance

Other characteristics: The Hawkeye is a derivative of the TTL Banshee target drone. Canada has purchased five to test suitability in a maritime role.

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[24] Unless otherwise noted, the information on this UAV is found in 31:836.

CL-227 Sentinel (Peanut):[25] (Canada)

Company: Canadair

Length: N/A

Wingspan: N/A

Weight: 250 kg (31:812)

Propulsion System: 32 hp engine driving rotors (31:812)

Range: 40 km (31:812)

Cruising Speed: Unknown

Endurance: 30 h (max) (31:812)

Operating/Penetration Altitude: Unknown

Payload: 22.7 kg (31:812)

Potential missions: Varietal

Other characteristics: The Sentinel is wingless with two counter rotating propellers. It can hover over a stationary target or maintain station over a moving target. It pops up to transmit data and can operate from a small platform. A cable lowered while hovering facilitates recovery.

---

[25] Unless otherwise noted, the information on this UAV is found in 7:40.

Stabileye Mk3:[26] (United Kingdom)

Company: British Aerospace PLC (Naval Weapons Division)

Length: 2.87 m (31:828)

Wingspan: 3.66 m (31:828)

Weight: 80 kg (31:828)

Propulsion System: Various two cylinder engines

Range: Unknown

Cruising Speed: 96-180 km/h (31:828)

Endurance: 4 h (31:828)

Operating/Penetration Altitude: 3,050 m (max) (31:828)

Payload: 25 kg (31:828)

Potential missions: Flight testing of payloads to date but could be configured for other missions

Other characteristics: Mini-UAV.

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[26] Unless otherwise noted, the information on this UAV is found in 7:40.

Stabileye Mk4:[27] (United Kingdom)

Company: British Aerospace PLC (Naval Weapons Division)

Length: 3.40 m

Wingspan: 3.66 m

Weight: 131.5 kg

Propulsion System: Various two cylinder engines

Range: Unknown

Cruising Speed: 126-162 km/h

Endurance: 4-7 h (dependent on payload)

Operating/Penetration Altitude: 3,960 m

Payload: 50 kg

Potential missions: Varietal

Other characteristics: Prototype mini-UAV.

---

[27] Unless otherwise noted, the information on this UAV is found in 31:828.

Scorpion:[28]

Company: Matra/Thompson-CSF

Weight: Unknown

Propulsion System: Unknown

Range: Unknown

Cruising Speed: Unknown

Endurance: Unknown

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Battlefield surveillance and reconnaissance.

Other characteristics: A mini-UAV in development.

---

[28] Unless otherwise noted, the information on this UAV is found in 7:40.

Argus II:[29]

Company: Dornier

Length: N/A

Wingspan: N/A

Weight: 458 kg

Propulsion System: 330 hp Boeing T50-BO-12 /turboshaft engine driving rotors. (31:816)

Range: Unknown

Cruising Speed: 145 km/h (31:816)

Endurance: 2 h 42 min (31:816)

Operating/Penetration Altitude: 3,000 m

Payload: 272 kg (31:816)

Potential missions: Reconnaissance

Other characteristics: The Argus II consists of the Mini-Telecopter MTC-II free flying helicopter drone fitted with the sensor suite from the Argus I (now cancelled). The Argus II meets the German Army's requirement for all-weather, day night situation and target reconnaissance. To date, no decision has been made by the German Army on a go ahead for the program.

---

[29] Unless otherwise noted, the information on this UAV is found in 22:1782.

Mirach 20 (Condor/Pelican):[30] (Italy)

Company: Meteor C.A.E. S.p.A.

Length: 3.61 m (31:822)

Wingspan: 3.83 m (31:822)

Weight: 150 kg

Propulsion System: One 26 hp, Herbrandson Dyad flat twin piston engine driving a two blade propeller (31:822)

Range: Unknown

Cruising Speed: 200 km/h (max level) (31:822)

Endurance: 4 h

Operating/Penetration Altitude: 3,500 m (31:822)

Payload: 25 kg (31:822)

Potential missions: Reconnaissance, target acquisition, target location, target designation, and defense saturation.

Other characteristics: Built for the Italian Army the Pelican carries a target acquisition radar and infrared sensor. The radar can detect shipping from an altitude of 1000 m at 80 km.

---

[30] Unless otherwise noted, the information on this UAV is found in 1:22.

Mirach 70:[31] (Italy)

Company: Meteor

Length: 3.66 m (31:822)

Wingspan: 3.57 m (31:822)

Weight: 260 kg

Propulsion System: 70 hp, piston engine (32:363)

Range: Unknown

Cruising Speed: 360 km/h (31:822)

Endurance: 1 h (32:363)

Operating/Penetration Altitude: Unknown

Payload: 20 kg

Potential missions: Target, EW, surveillance

Other characteristics: The Mirach 70 is about the same size as the Mirach-20 and has the cruise motor located in the nose.

---

[31] Unless otherwise noted, the information on this UAV is found in 23:1785.

Mirach 100:[32] (Italy)

Company: Meteor

Length: 4.32 m (31:822)

Wingspan: 1.80 m (31:822)

Weight: 310 kg

Propulsion System: turbojet

Range: Unknown

Cruising Speed: 860 km/h (32:363)

Endurance: 1 h (32:363)

Operating/Penetration Altitude: Unknown

Payload: 40 kg

Potential missions: Target, surveillance, reconnaissance

Other characteristics: The Mirach-100 that is normally ramp launched from a truck or trailer by two jettisonable rocket boosters. The Italian Army has purchased the vehicle for training targets. The reconnaissance/surveillance version can be launched/recovered by helicopter. The heliborne version is in service in several countries.

---

[32] Unless otherwise noted, the information on this UAV is found in 23:1785.

Mirach 300:[33] (Italy)

Company: Meteor

Length: 5 m (31:822)

Wingspan: 2.83 m (31:822)

Weight: 800 kg (31:822)

Propulsion System: TRS-60 turbojet (32:363)

Range: Unknown

Cruising Speed: Mach 0.9 (32;363)

Endurance: 140 min (32;363)

Operating/Penetration Altitude: Unknown

Payload: 150 kg (31:822)

Potential missions: Varietal

Other characteristics: Surveillance, reconnaissance, target location/acquisition/attack, EW missions are possible with different payloads. (32:363) Primary design mission is long range reconnaissance. (23:1785)

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[33] Unless otherwise noted, the information on this UAV is found in 23:1785.

Mirach 600:[34] (Italy)

Company: Meteor

Length: 6.10 m (31:822)

Wingspan: 3.60 m (31:822)

Weight: 1000 kg (31:822)

Propulsion System: Two TRS-60 turbojets (32:363)

Range: Unknown

Cruising Speed: Mach 0.9 (32:363)

Endurance: 80 min (32:363)

Operating/Penetration Altitude: Unknown

Payload: 300-500 kg (31:822)

Potential missions: Varietal

Other characteristics: Surveillance, reconnaissance, target location/acquisition/attack, EW missions are possible with different payloads. (32:363) The 600 is in development and possible future roles include interception. (23:1785)

---

[34] Unless otherwise noted, the information on this UAV is found in 23:1785.

APPENDIX C

UAVs--OTHER COUNTRIES

This appendix addresses unmanned air vehicles in production or development by countries other than the United States and NATO. It does not include information on Soviet Union or Chinese UAV developments because of the lack of information available. Also, it does not provide detail on unmanned air vehicles that are used as targets, although these target vehicles could possibly be engineered for other missions. There are approximately 12 types or series of target UAVs. A description of most target UAVs can be found in Jane's: All the World's Aircraft 1986-1987 or Jane's: Weapon Systems 1986-1987. (31:809-855) (32:356-379)

Scout:[1] (Israel)

Company: Mazlat Ltd.

Length: 3.68 m

Wingspan: 4.96 m

Weight: 159 kg

Propulsion System: 22 hp, two cylinder, rear mounted engine driving a two blade pusher propeller

Range: 54 km

Cruising Speed: 176 km/h (max)

Endurance: 7 h

Operating/Penetration Altitude: 4,575 m (max)

Payload: 38 kg

Potential missions: Varietal

Other characteristics: Israel has used the Scout successfully in several military operations. It can be configured for reconnaissance, battlefield control, target identification, strike force control, artillery targeting, border patrol, coastal and waterway control, and damage assessment. The Scout has been exported to several countries including South Africa and Switzerland.

---

[1] Unless otherwise noted, the information on this UAV is found in 31:820.

Mastiff:[2] (Israel)

Company: Tadiran/Mazlat

Length: 3.30 m

Wingspan: 4.25 m

Weight: 138 kg

Propulsion System: 22 hp, two cylinder engine driving a two blade pusher propeller

Range: 135 km

Cruising Speed: 98 km/h

Endurance: 7 h 30 min

Operating/Penetration Altitude: 4,480 m (max)

Payload: 37 kg

Potential missions: Reconnaissance, surveillance, target designation, and artillery spotting.

Other characteristics: The Mastiff uses conventional takeoff and landing with non retractable tricycle landing gear. It is remotely controlled from a ground station which is normally carried on a 2 1/2 ton truck.

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[2] Unless otherwise noted, the information on this UAV is found in 31:820.

Pioneer:[3] (Israel)

Company: Mazlat Ltd.

Length: 4.96 m (31:820)

Wingspan: 5.12 m (31:820)

Weight: 195 kg (31:820)

Propulsion System: 26 hp, Sachs two cylinder engine driving a two blade pusher propeller

Range: 185 km

Cruising Speed: 90–130 km/h

Endurance: 9 h

Operating/Penetration Altitude: 5000 m

Payload: 45 kg

Potential missions: Reconnaissance, surveillance

Other characteristics: The Pioneer is an outgrowth of the Scout program and the US Navy and USMC has procured two systems comprising 15–24 vehicles. Each system includes a mobile control station, back-up control station, net retrieval system, battlefield radio receiver equipment, and logistics equipment.

---

[3] Unless otherwise noted, the information on this UAV is found in 1:25.

BQM-1 BR:[4] (Brazil)

Company: Compnahia Brasileira de Tratores

Length: 3.89 m (31:810)

Wingspan: 3.18 m (31:810)

Weight: 93 kg (31:810)

Propulsion System: 0.30 kN turbojet engine (31:810)

Range: Unknown

Cruising Speed: Unknown

Endurance: 45 min (31:810)

Operating/Penetration Altitude: Unknown

Payload: Unknown

Potential missions: Target, reconnaissance, attack

Other characteristics: Unknown

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[4] Unless otherwise noted, the information on this UAV is found in 7:40.

MQ-2 Bigua:[5] (Argentina)

Company: Quimar

Length: 3.90 m

Wingspan: 1.80 m

Weight: 260 kg

Propulsion System: 1.13 kN turbojet engine

Range: 216 km

Cruising Speed: 850 km/h (max level)

Endurance: 1 h

Operating/Penetration Altitude: 9,000 m (max)

Payload: 40-70 kg

Potential missions: Target, target acquisition, reconnaissance, EW

Other characteristics: The Bigua is a version of the Quimar recoverable target drone.

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[5] *Unless otherwise noted, the information on this UAV is found in 31:809.*

Eyrie (HP85):[6] (South Africa)

Company: National Dynamics (Pty) Ltd.

Length: 3.81 m

Wingspan: 4.88 m

Weight: 222 kg

Propulsion System: 85 hp, two cylinder engine driving a two blade propeller

Range: 1,888 km

Cruising Speed: 113 km/h

Endurance: 14 h

Operating/Penetration Altitude: 5,595 m

Payload: 53 kg

Potential missions: C3I and rocket strike

Other characteristics: High performance, all weather day/night system.

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[6] Unless otherwise noted, the information on this UAV is found in 31:823.

Eyrie (LE40):[7] (South Africa)

Company: National Dynamics (Pty) Ltd.

Length: 3.81 m

Wingspan: 4.27 m

Weight: 222 kg

Propulsion System: 40 hp, two cylinder engine driving a two blade propeller

Range: 3,151 km

Cruising Speed: 113 km/h (loiter)

Endurance: 24 h 36 min

Operating/Penetration Altitude: 3,050 m

Payload: 45.5 kg

Potential missions: Varietal

Other characteristics: Long range and endurance version. It does not have rocket capability.

---

[7] Unless otherwise noted, the information on this UAV is found in 31:823.

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