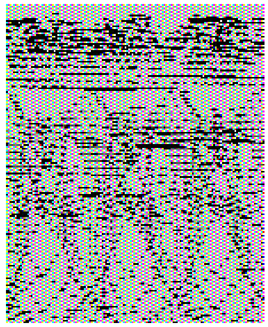

Special Operations Forces and Unmanned Aerial Vehicles

Sooner or Later?

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Abstract

This study analyzes whether special operations forces (SOF) should use unmanned aerial vehicles (UAV) to support intelligence, surveillance, reconnaissance, communications, and resupply capability deficiencies. The author's objective is to review the missions and requirements of the United States Special Operations Command, examine current and future unmanned aerial vehicle technologies, and analyze whether unmanned aircraft technologies are mature enough to meet the demanding special operations mission. The result of the analysis is that unmanned aerial vehicles have tremendous potential. But, due to the technological limitations and a lack of systems maturity, unmanned aerial vehicles lack the range, reliability, datalink capability, and size to meet SOF needs at this time. However, in the future, UAVs should be able to fulfill several SOF capability deficiencies.

About the Author

Maj Stephen P. Howard was commissioned through the Officer Training School, Lackland AFB, San Antonio, Texas, in 1982. Graduating from undergraduate navigator training in 1982 and electronic warfare officer (EWO) training in 1983, he went on to fly AC 130H Gunships as an EWO in the 16th Special Operations Squadron, 1st Special Operations Wing, Hurlburt Field, Florida. In 1987 he went to the Joint Staff, J-3, Joint Operations Division, for an Air Staff training assignment. He was subsequently selected to transition into EC-130H Compass Call aircraft and served as a mission crew commander with the 6919th Electronic Security Squadron, Sembach Air Base (AB), Germany, and as the interim squadron commander for the 6915th Electronic Security Squadron, Bad Aibling Station, Germany. During Operation Desert Storm, he flew missions against Iraq as the mission crew commander on the EC-130H and served as the wing electronic combat coordinator and combat mission planner, with the 7405th Composite Wing (Provisional), Incirlik AB, Turkey. After the war, he was assigned to Headquarters United States Air Forces Europe in the Operational Requirements Division. Major Howard is a senior navigator with more than 1,500 flying hours. He has a bachelor's degree in history from the University of Maryland and a master's degree in international relations from Troy State University. In October 1995, Major Howard was assigned to the United States Special Operations Command as a strategic planner.

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Most importantly, I express my sincere appreciation to my wife, Glenda, and daughter, Jenessa, for their love, patience, and understanding during those times when I was struggling with this study. Their presence (or lack of it) was very important to me and made all the difference in ensuring my success in completing this work.

Chapter 1

Introduction

What is called "foreknowledge" cannot be elicited from spirits, nor from gods, nor by analogy with past events, nor from calculations. It must be obtained from men who know the enemy situation.

—Sun Tzu
The Art of War

The cold war may be over, but there are numerous smaller conflicts raging around the world. Because the United States is not always "invited" to intervene in local or regional squabbles, there are still significant areas of the world where overt US action is discouraged. Many of these regions are important to US national interests and may require fast, politically acceptable uses of force that provide information and firepower without needlessly endangering lives.

Special operations forces (SOF) are capable of dealing with sensitive situations by using overt and covert means. As situations and adversaries become more complex, SOF leaders will need a greater capability for observing their targets. Surveillance, reconnaissance, and communication assets that deliver near-real-time, full motion video for extended periods of time will be required. They will also need communication systems that are secure, have a low-probability-of-intercept, and which extend beyond traditional line-of-sight capabilities. To successfully achieve these increasingly difficult tasks, SOF leaders will need specific and responsive intelligence information that may not otherwise be available through conventional national assets.[1]

Unmanned aerial vehicles (UAV) are among the many tools at the disposal of SOF leaders for dealing with difficult situations. My objective of this study is to explore and evaluate current and future UAVs and determine whether they solve any of the capability deficiencies affecting special operations forces' ability to meet future tasking. Consequently I address the question whether SOF leaders should continue relying only on manned aerial assets and national space assets for reconnaissance and surveillance, or if they should shift to developing unmanned aerial assets for some of these purposes. My study gives military and civilian leaders within the Department of Defense background information to make informed decisions about using unmanned aerial vehicles in the future.

Special operations forces traditionally have relied on manned aircraft, special reconnaissance teams, and satellites to provide timely surveillance, reconnaissance, and communications information. All of these assets have proved useful as information providers.Still, recent unmanned aerial vehicle successes during Operations Desert Shield and Desert Storm have created new tension between groups advocating unmanned systems versus manned systems for high-risk operations.

With the fall of the Soviet Union and the emergence of a multipolar world, special operations forces are being tasked with more missions and challenges than ever before. Since the Department of Defense Reorganization Act of 1986, special operations' missions have expanded from the traditional unconventional warfare and foreign internal defense tasks into several new areas of responsibility. These new areas include combating terrorism, halting the proliferation of weapons of mass destruction, and information warfare. The United States Special Operations Command (USSOC) is aware of its growing responsibilities and is trying to meet these future challenges by developing new weapons and assets today. I summarize SOF mission areas and responsibilities in chapter 2 and conclude with a presentation of SOF capability deficiencies.[2]

Once SOF capability deficiencies are exposed, I introduce the reader to one possible technology solution: UAVs. Chapter 3 provides basic, unclassified characteristics and capabilities of many of the unmanned aerial vehicles currently developed or in the prototype stage. I also discuss civilian uses and potential programs that offer cost sharing between commercial and government agencies. Foreign technologies are not discussed in this chapter because the details of these programs are classified.

Chapter 4 marries the capability deficiencies highlighted in chapter 2 to a variety of potential resolutions. Mission area plans, mission need statements, and USSOC's list of technology development objectives are used to analyze the advantages and disadvantages of numerous assets used to support special operations. The purpose of this chapter is to systematically evaluate the tools used by SOF to determine if there are scenarios that are better served by assets not currently being used or considered.

My conclusions and recommendations are straightforward deductions from the analysis. There are certain SOF missions that need manned systems. There are also other places, times, and situations when unmanned assets are a logical alternative. In the situations where UAVs are useful, I suggest ways to integrate the assets into current force structure. This study provides rudimentary inputs for commanders and planners to help them integrate UAVs into their planning process. Many of the UAVs mentioned are currently available and can be procured by special operations forces within a few months. Other systems may never be available due to inefficient programs, cost overruns, and lack of support by either the Department of Defense or the Congress. Several previous unmanned aerial vehicle programs have been started and canceled over the years.[3]

What is the bottom line? Should SOF continue relying solely on the aircraft, ground teams, and satellites which have served them in the past, or, should they divert some of their limited resources toward adding a fourth dimension to their repertoire of assets?

Notes

1. Headquarters Air Force Special Operations Command/XPP, Air Force Modernization Plan, Mission Area Plans (1 December 1993): "Joint Air-SOF Battlefield Interface," 34–35; "Force Application," 26–28; "Psychological Operations (PSYOP)," 24–27; and "Aviation Foreign Internal Defense," 27–29.

2. Glenn A. Kent, *A Framework for Defense Planning*, August 1989, prepared for the USAF and Office of the Secretary of Defense, RAND Corporation. According to Kent, operational mission requirements from the field are to be fed into military technology acquisition as capability deficiencies only and not as technology requirements. This ensures capability deficiencies are addressed but does not inhibit the creative and innovative application of new technologies from optimally satisfying those deficiencies.

3. See Department of Defense, Deputy Under Secretary of Defense (Advanced Technology), document titled, "Unmanned Aerial Vehicles (UAV) Program Plan" (Washington, D.C.: Defense Airborne Reconnaissance Office April 1994, chap. 7), for a brief history of UAV programs that never really "got off the ground."

Chapter 2

Special Operations Tasks and Capability Deficiencies

The revolutions which gave us birth ignited, in the words of Thomas Paine, "a spark never to be extinguished." And across vast, turbulent continents these American ideals still stir man's struggle for national independence and individual freedom.

—John F. Kennedy

Revolutions, struggles for national independence, and groups yearning for individual freedom are causing strife and discord around the globe. Guarding against threats to the interests of the United States requires the appropriate use of military force in concert with political, economic, and informational elements of national power. Therefore, the Armed Forces of the United States are engaged in accomplishing two national military objectives—promoting stability and thwarting aggression.[1]

Capabilities

Special operations are a form of warfare characterized by a unique set of objectives, weapons, and forces. These forces are best used when large, conventional forces, requiring extensive support structures, are not militarily required or are politically unacceptable to host-nation and regional sensibilities.

Special operations forces' (SOF) capabilities are a function of individual and small units proficient in a multitude of specialized, often unconventional, combat skills using innovation, improvisation, and self-reliance. Special operations size, self-sufficient nature, and capabilities provide a military response that entails less political liability or risk of escalation normally associated with employment of larger, more visible, conventional forces.[2]

Characteristics

Special operations have certain characteristics that distinguish them from conventional operations.[3] They are principally offensive in nature and incur high physical risk while limiting political risk for the United States. However, if things go wrong and their mission fails or becomes public knowledge, then these operations can involve very high political risk.[4]

SOF units are regionally focused and primarily directed at high-value, critical, and often perishable targets. Special operations forces conduct fast, surgical operations at great distances from established support bases by using sophisticated communications, aircraft, and specially trained forces. These forces infiltrate and exfiltrate areas that are hostile to the United States, or politically sensitive to overt displays of US military forces. Timely, relevant intelligence is crucial to successful special operations.

Very short contingencies using shock and surprise, or long-term commitments requiring patience and cultural understanding are typical of special operations. Combining high- and low-technology weapons and equipment, these forces can provide security assistance to friendly nations by training and organizing indigenous forces internal or external guerrilla forces. In-depth knowledge of the region and its inhabitants means the difference between success and failure.

Special operations forces are often tasked by political leaders and monitored at the national level. These operations cross all services and need detailed planning and rapid coordination with other commands, services, and governments agencies. Because of the nature of the missions, joint ground, air, and maritime assets must communicate quickly and efficiently. Therefore, a common, responsive command and control network is needed that interconnects the various commands, services, and government agencies.

Special operations forces are responsible for several activities. These are broken down into seven principal missions or “core tasks” with additional “collateral tasks” and “emerging tasks.”

Seven Core Tasks

Section 167 of Title 10, of the *US Code* defines 10 special operation activities. For strategic planning purposes, SOF tasks are identified as core, collateral, or emerging tasks.[5] Seven of the 10 activities are described as core tasks—unconventional warfare, direct action, special reconnaissance, foreign internal defense, combating terrorism, psychological operations, and civil affairs.

These core tasks need real-time intelligence, redundant, long-range communications, and the ability to resupply operators working in the field for extended periods of time. These tasks have always been supported by manned aircraft, tactical and national reconnaissance assets, and the ingenuity of the personnel on the ground.

Unconventional warfare includes guerrilla warfare and other low-visibility, covert, or clandestine operations. It also includes subversion, sabotage, intelligence activities, and escape and evasion.[6]

Guerrilla warfare usually occurs in enemy-held or hostile territory by military and paramilitary forces. Unable to attack the main enemy force, these irregular troops raid and ambush enemy forces where they are most vulnerable. Guerrillas use subversion and sabotage against their targets. Subversion undermines the political, economic, and military morale of a nation or regime. Sabotage selectively destroys or disrupts the infrastructure of the target government. The primary guerrilla objective is to discredit the legitimacy of the government in power. This is the area which Max G. Manwaring believes is the single most important dimension where a government either succeeds or fails.[7] The organization with the most effective intelligence and communications systems is usually victorious.

Direct action operations are short-duration strikes designed to seize, destroy, capture, recover, or inflict damage on specific personnel or assets. Highly trained teams are used for time-sensitive, high-priority targets. These operations are usually conducted against perishable or fleeting targets. SOF units must frequently accomplish the mission with little preparation time and limited intelligence. These missions are particularly high risk if the situation changes before the teams involved get updated information. Typical missions include locating and recovering persons held captive and isolated and often occur in parts of the world that are sensitive or denied to conventional military forces. The Son Tay Raid during the Vietnam War is a good example of a well-planned and executed operation that failed because it lacked timely intelligence. When the Special Forces teams arrived, the American prisoners of war had already been moved and the camp was nearly empty.[8]

Special reconnaissance is human intelligence that places special teams in hostile or politically sensitive areas of the world. Their mission is to provide strategic or operational intelligence that complements or supplements national and theater intelligence assets. Special recce teams are often the "eyes and ears" of unconventional warfare, direct action, counterterrorism, and foreign internal defense operations. Long range, low probability of intercept and detection radios are needed to improve team communications. The ability to broadcast digital imagery over long distances is also needed to increase the teams' overall eyes-and-ears capability.

Foreign internal defense primarily helps host-nation political and military leaders eliminate internal instability and insurgency operations. Like unconventional warfare, foreign internal defense is made up of several different skills, tactics, and capabilities. SOF involvement requires cultural awareness and linguistic skills. Additional requirements include strong medical skills, basic construction, and engineering skills, in addition to traditional weapons and demolition skills. However, the US special operations forces assisting the host-nation do not become directly involved. They are advisors and observers, not participants.

Resupplying these teams in the field is often challenging because the SOF teams can work great distances from base camps and major supply points. Teams traverse difficult terrain or parachute into extremely isolated areas where ground transportation is nonexistent. Once in place, the team members soon exhaust the limited supplies they brought with them. Reliable, accurate aerial resupply is crucial to allowing the people on the ground to continue their mission.

Combating terrorism requires highly trained personnel who can preempt or resolve terrorist incidents outside the United States. There may be no task more intelligence-intensive than finding, isolating, and capturing terrorists. The secretive nature of terrorists cells makes neutralizing their activities very difficult. Elements of special operations forces will rescue hostages, attack terrorist infrastructure, and recover sensitive materiel from terrorist organizations when sufficient, timely intelligence is available to successfully complete the mission.

Psychological operations (psyops) "convey selected information and indicators to foreign audiences to influence their emotions, motives, objective reasoning . . . and behavior."[9] This task has received a lot of attention because of numerous successful leaflet drops during military operations in Panama, Iraq, and Bosnia. These psychological operations were effective when the leaflets were accurately delivered to the right targets. Currently there are no dedicated delivery systems for getting leaflets on target over friendly or hostile territory. Available aircraft are tasked to drop the leaflets, thus sometimes having limited results because aircrews were improperly trained and equipped to do the mission.[10]

The final core task is civil affairs. In this capacity military forces may assume functions normally the responsibility of the local government. The objective is to establish, maintain, influence, or exploit relations among military forces, civil authorities, and civilian populations to facilitate military operations.[11] Communications and resupply are important aspects of accomplishing this task.

Collateral Tasks

Collateral special operations activities apply special operations capabilities in areas beyond the core tasks. These areas include security assistance, humanitarian assistance, peace operations, coalition support, counterdrug operations, personnel recovery, and special activities.[12]

Security assistance is a group of programs authorized by the Foreign Assistance Act of 1961. Under these programs, the US government sells defense articles and services, including military training, to eligible foreign countries. Personnel providing security assistance are prohibited by law from performing combatant duties.[13]

Humanitarian programs are primarily designed to promote nonmilitary objectives within a foreign civilian community and are usually conducted to relieve or reduce pain, disease, and hunger that results from natural or man-made disasters. Peacetime military operations are a nonhostile situation where political, economic, psychological, and military measures, short of US combat operations, are employed to achieve national objectives.[14] SOF skills help host-nation agencies train personnel to develop military and paramilitary infrastructure and capabilities.[15] In many cases SOF units need to apply their unique characteristics and provide liaison to coalition partners. Their linguistic abilities, regional orientation, and focus on independent small unit actions make them one of the principal forces of choice to complement and support coalition warfare objectives.[16]

Another collateral activity for SOF is counterdrug operations which are designed to disrupt, interdict, and destroy illicit drug activities. To the extent permitted by law, special operations forces lend operational and training assistance to US federal, state, and local law enforcement agencies. As a general rule under the *Posse Comitatus Act* (Article 18 of the *US Code* 1385) DOD personnel and equipment may not be used in a domestic law enforcement capacity. However, in 1981, Congress enacted an exception that authorized specific DOD assistance in drug interdiction and drug eradication operations (Article 10, *US Code* 371-380). SOF has traditionally provided special reconnaissance and surveillance technology and techniques to law enforcement agencies.[17] Therefore, the ability to have reliable, 24-hour sensor coverage, and communications systems that can transmit and receive large amounts of information over long distances are very important capabilities for aiding civilian law enforcement officers.

Although the conventional forces have the responsibility to search for and recover downed or stranded personnel, special operations forces may be needed to perform personnel recovery operations. Not organized, equipped, or trained to conduct search and rescue operations, SOF can nonetheless use their sophisticated airpower assets to find and extract personnel needing assistance. Personnel recovery missions resemble direct action operations and often occur in hostile or denied territory.[18]

Special activities are governed by Executive Order 12333, require a presidential finding, and also call for congressional oversight. These "activities" may involve any of the primary special operations tasks and missions and are conducted abroad in support of national foreign policy objectives. Special activities are extremely low profile so US government participation is neither apparent nor acknowledged.[19] Sophisticated, high-technology equipment of all types are important for accomplishing these high-risk, potentially sensitive activities.

Emerging Tasks

Special operations forces are also preparing for future tasks. Some of the emerging missions that may affect special operations are weapons of mass destruction (WMD) counterproliferation, and information warfare. These areas have the potential of becoming either core or collateral tasks.[20] Because of the increasing threat from WMD, special operations forces may need to become involved in counterproliferation operations.

If countries and organizations hostile to the United States continue to acquire weapons of mass destruction, special operations forces may have to carry out intrusive verification measures to support compliance with international arms control agreements. The ability to unobtrusively sample the air and environment for toxins or radiation is needed by both military and civilian agencies and organizations. The ability to provide deep reconnaissance, surveillance, and precise direct action attacks will continue to be a cost-effective means of reducing proliferation of weapons dangerous to US national interests.[21] Timely intelligence, advance sensors, and a reliable means to communicate the information are needed to thwart continued proliferation of weapons of mass destruction.

Another emerging task for special operations forces is in the area of information warfare. This is a new realm of warfare[22] that is still ill-defined. One definition for information warfare is ". . . any action to deny, exploit, corrupt or destroy the enemy's information and its functions; protecting ourselves against those actions; and exploiting our own information operations."[23] Finding means to exploit information and employing that information against the enemy will be needed. Direct action teams and psychological operators may be well suited for supporting this area.

Information warfare, like counterproliferation, are methods, technologies, and techniques that are rapidly changing. The challenge to special operations forces is to find a way to be proactive instead of reactive. The nation that gets in front of these two areas may be the nation that stays in front for the next hundred years.

Capability Deficiencies

In order to meet the myriad of tasks facing special operations forces and to ensure that special operations forces have the appropriate equipment and resources, Congress authorized USSOCOM its own program, budget, and head-of-agency authority for research, development, and acquisition of special operations unique material and equipment. In keeping with these directives, USSOCOM has established a system for determining resource requirements.[24]

USSOCOM is currently using a modernization process that begins with a strategy review to determine where the capabilities and attributes of special operations military power are incorporated into various joint strategy documents. The process follows an approach of strategy-to-task, task-to-need, need-to-concept, concept-to-technology need, technology need-to-technology, and technology-to-execution (or acquisition).[25] Based upon the myriad of requirements dictated by the core, collateral, and emerging tasks, the 1994 USSOCOM mission needs analysis process produced several capability deficiencies (see table 1).

In addition to the capability deficiencies, the USSOCOM Requirements Review Board established a priority listing of 11 technology development objectives as a means of consolidating material solutions to the given capability deficiencies.[26] The list which follows is their list of technology goals for all exploratory and advanced technology research and development efforts. USSOCOM technology development objectives in order of priority are

1. weapons of mass destruction (WMD) detection, classification, neutralization, and protection systems.
2. lightweight, low-volume survival, sustainment, and personal equipment;
3. lightweight, low-volume power supply, storage, and generation technologies;
4. high-speed, low-detectable, all-weather SOF mobility platforms;
5. improved communications (C^4) systems;

6. passive shallow water/terrestrial mine, explosive, and booby-trap detection and neutralization equipment and systems;

7. target locating, tracking, and marking technologies;

8. future force application weapons and munitions and enhanced explosives and munitions;

9. advanced vision devices, sensors, fire controls for SOF weapons, and human sensor enhancement equipment;

10. information warfare (IW) and command and control warfare (C^2W) systems; and

11. advanced learning, training, and mission planning/rehearsal systems.[27]

Table 1

USSOCOM Mission Area Plan Capability Deficiencies

Factors	**Deficiencies**
Command, Control, and Communications	Limited SATCOM capability SATCOM jammable/spoofable Limited accessibility, coverage, bandwidth, size, and weight Potential for enemy to monitor or destroy our information systems
Intelligence	No real/near-real-time imagery from national systems No real-time interface between aircraft, planners, and intel systems No-real-time imagery for target study No automatic enroute threat replan Lack data file for possible contingencies No all-source threat location data Enhanced target identification and marking capability required
Resupply	Need resupply of expendables (batteries, food, water, medical supplies, and ammunition) Need to deliver leaflets over high-risk areas

Sources: Headquarters Air Force Special Operations Command/XPP, Air Force Modernization, Mission Area Plans (1 December 1993)—"Force Application," "Joint Air-SOF Battlefield Interface," "Psychological Operations (PSYOP)," and the USSOCOM Mission Need Statement for the Psychological Operations Unmanned Aerial Vehicle Payloads (UAV-P), USASOC 92-134, 31 October 1994.

These technology objectives are not a violation of Kent's notion that operators should or need only supply capability deficiencies. The technology objectives are so general that they still allow innovative technological alternatives from the science and technology community.

Before addressing these capability deficiencies and technology development objectives with a multitude of potential solutions, the next chapter offers a detailed description of a single material option: UAVs. This is not presented a priori as the capability deficiencies resolution of choice but only as informing of one possible alternative.

Notes

1. *National Military Strategy of the United States of America*, "A Strategy of Flexible and Selective Engagement," Washington, D.C.: Government Printing Office,1995, 4–5.

2. Joint Pub 3-05, change one, "Doctrine for Joint Special Operations," draft, 28 January, 1994, I-3.

3. USSOCOM Strategic Planning Guidance (U), 1 March 1995, 3.

4. The covert nature of special operations is designed to reduce political risk. However, should a mission fail—like Desert One, the Iranian hostage rescue mission—the political risks and fallout are greater than that of a conventional operation. If covertly done, allowing plausible deniability by the nation instigating the incident or operation, then political risks are low as long as no single nation can be blamed.

5. USSOCOM Strategic Planning Guidance (U), 1 March 1995, 2.

6. For more in-depth definitions and explanations refer to chap. 2, "Forces and Missions," in the Joint Chiefs of Staff, Joint Pub 3-05, II-1–13.

7. Max G. Manwaring, "The Threat in the Contemporary Peace Environment: The Challenge to Change Perspectives," in Edwin G. Corr and Stephen Sloan, eds., *Low-Intensity Conflict: Old Threats in a New World* (Boulder, Colo.: Westview Press, 1992). The Manwaring Paradigm states that the underlying premise is that "the ultimate outcome of any counterinsurgency effort is not primarily determined by the skillful manipulation of violence in . . . many military battles." Rather, the outcome will be determined by "(1) legitimacy of the government, (2) organization for unity of effort, (3) type and consistency of support for the targeted government, (4) ability to reduce outside aid to the insurgents, (5) intelligence (or action against subversion), and (6) discipline and capabilities of a government's armed forces."

8. Benjamin F. Schemmer, *The Raid* (New York: Harper & Row, 1976), 249–50.

9. *United States Special Operations Forces Posture Statement, 1993*, D-4.

10. Interview with members of psychological operations team temporarily assigned to Incirlik Air Base, Turkey, during Proven Force/Desert Storm, 27 February 1991. The individuals interviewed asked to remain anonymous.

11. "USSOCOM Strategic Planning Guidance," 1 March 1995, 8.

12. Ibid., 2.

13. *United States Special Operations Forces Posture Statement*, D-4.

14. JCS Pub 3-0, and JCS Pub 3-05, change one, "Doctrine For Joint Special Operations," 28 January 1994, I-8.

15. JCS Pub 3-05, change one, "Doctrine For Joint Special Operations," 28 January 1994, I-8.

16. Ibid., II-15–16.

17. Ibid., II-15, and *United States Special Operations Forces Posture Statement*, 1993, 34 and D-1.

18. Joint Pub 3-05, change one, II-15, and *United States Special Operations Forces Posture Statement*, 1993, 35.

19. Joint Pub 3-05, change one, II-15.

20. USSOCOM Strategic Planning Guidance, 1 March 1995, 2.

21. United States Special Operations Forces Posture Statement, 1993, 33–34.

22. The 1995 draft version of AFM 1-1 includes information as a realm equivalent to land, sea, and air.

23. Definition taken from a briefing given by Maj Andy Weaver, USAF/XOXD, Doctrine Division, Pentagon, Washington, D.C., 27 January 1995.

24. Title 10, *United States Code*, sec. 167.

25. "The Air Force Special Operations Forces (SOF) Development Plan," 1 September 1994, prepared by SOF Technical Planning Integrated Product Team (TPIPT), 1-1 and 1-2.

26. Memorandum, from the commander, United States Special Operations Command, dated 3 November 1994, subject: USSOCOM's Technology Development Objectives (TDO).

27. Ibid.

Chapter 3

Current and Emerging UAV Technologies

He that will not apply new remedies must expect new evils; for time is the greatest innovator.

—Francis Bacon

This chapter describes current and projected unmanned aerial vehicle (UAV) technologies and provides unclassified characteristics and capabilities of a few unmanned aerial vehicles that either currently exist or will be available within five to ten years. But first, in order to have a common vernacular and to avoid misunderstanding, it is important to define unmanned aerial vehicles, drones, and remotely piloted vehicles (RPV).

Unmanned aerial vehicles are powered aerial vehicles sustained in flight by aerodynamic lift over most of their flight path and guided without an onboard crew. They are expendable or recoverable and can fly autonomously or be piloted remotely. There are two main subcategories of unmanned aerial vehicles, drones and remotely piloted vehicles.[1] Drones are autonomous and automatic pilotless aircraft carrying a mechanism to sustain stable flight that will fly an uncorrected steady heading and usually programmed to be a target. Their course is preprogrammed and cannot be altered during flight.[2] Remotely piloted vehicles are unmanned aircraft capable of being controlled from a distant location through a communication link and are normally designed to be recoverable and nonautonomous. They are capable of transmitting mission-related data to a remote controller and reacts to operator commands as well as to other control inputs.[3]

Because of the special requirements and needs of special operations forces, I examine unmanned aerial vehicles that are remotely piloted, reprogrammable, and capable of receiving inflight course changes and corrections from a controller site. As discussed in the previous chapter, special operations forces have a critical need for vast amounts of real-time or near-real-time intelligence. Sensors that provide video images, 24 hours a day, regardless of weather conditions, are needed to provide information to special teams operating on land, sea, and in the air. Currently these forces rely on manned aircraft and national sensor assets, like RC-135 and U-2 aircraft, and various satellites, for their information. However, these information providers are too few, have no real-time capability, and are very difficult to task for small operations that may not have sufficient priority. Operational security also becomes more difficult when RC-135, joint surveillance, target attack radar system (JSTARS), or Airborne Warning and Control System (AWACS) aircraft loiter along a hostile border.

In addition to real-time images, the SOF community needs portable, lightweight communications equipment that transmits and receives beyond line of sight. This equipment also needs to be sophisticated enough to be difficult to intercept or detect because many SOF teams perform their mission by remaining concealed. Current radio and communications equipment is susceptible to jamming and interception. This gives away the team's location, prevents its information from reaching command authorities, and endangers the team members' lives. Directional, high-frequency, low-power transmitters and receivers that can be relayed around the world are more difficult to jam or intercept. Current satellite communications systems that are secure and difficult to intercept tend to be bulky. Miniaturizing the communications system, while increasing range and effectiveness, is the desired end result.

SOF also needs to resupply these teams. Already overburdened with equipment, weapons, and ammunition, the average team member carries a 72-hour supply of food, water, and expendables. Air Force Special Tactics Team members are typically loaded with transceivers, navigational aids, medical supplies, weapons, ammunition, and food weighing between 70 and 80 pounds.[4] Safe, reliable resupply vehicles are needed to support the teams. Unmanned aerial vehicles are one of many areas being examined to meet the intelligence, communications, and resupply needs of special operations forces.

Current and Emerging Unmanned Aerial Vehicles

Unmanned aerial vehicles are classified according to two primary categories—tactical and endurance. Tactical unmanned aerial vehicles typically have a flight time of 10 hours or less and an operating radius no greater than 150 miles. Endurance unmanned aerial vehicles exceed these capabilities. Therefore, this study uses range, radius, and endurance as the dividing line between systems.

I do not examine all the UAVs currently available or in prototype. This chapter provides a rough overview of technologies that are becoming available. The specific UAV is not what is important. What is important is whether UAV technologies can be readily modified to meet SOF capability deficiencies in intelligence, communications, and resupply. When evaluating UAVs, keep in mind the SOF need for reliable, long-range systems that require little logistical support or air vehicles with sufficient range and endurance that they can be launched hundreds of miles from the team's location, provide support, and not alert the enemy to the presence of a ground, sea, or air team.

Tactical Unmanned Aerial Vehicles

Close-range unmanned aerial vehicles are designed to support land forces in the "close battle." These aircraft support commanders in urban operations, reconnaissance, surveillance, target acquisition (RSTA) operations, and battle damage assessment (BDA). The area of operation for these aircraft is usually within 30 kilometers of the forward line of own troops (FLOT). Initially these UAVs have been designed to support conventional forces in the field with no consideration for SOF unique needs and requirements. Some of the UAVs currently in this category are the Pointer hand launched vehicle and the BQM-147A Exdrone.[5]

Pointer *hand launched UAV*. The Pointer hand launched system is a low-cost[6] reconnaissance UAV designed to support maneuver battalion commanders or other users needing a short range "eye in the sky." This aircraft is powered by a 300-watt electric motor with a folding pusher propeller. The flight control system consists of an uplink that only allows a range of about 5–7 kilometers from the ground control unit. It is made of composite materials and is easily assembled from six parts that are interchangeable with other air vehicles. It has a nine-foot wingspan and a six-foot fuselage length. Its total takeoff weight, with payload, is 8.5 pounds. It currently carries a payload of either a color TV camera or a black and white low-light-level TV camera, which provides real-time, high-resolution video imagery. This hand launched system performs numerous close-in reconnaissance and surveillance missions without endangering ground personnel. Its small size and battery driven engine make it very difficult to see or hear. Missions are relatively short, normally lasting one hour or less. The aircraft is under positive control by the three-person ground crew and possesses no autonomous capability.

The positive aspects of Pointer include its low cost, rapid response time, minimal crew, and limited logistics burden to the field commander. The system has the flexibility to provide real-time video to the front echelon commander during hours of daylight. However, the negative aspects of the system are also significant. The "users" have determined that it needs an improved navigational and night imagery capability. Currently the system provides video only during daylight and twilight hours.

A Pointer package includes a three-man operations team, three UAVs, and a man-portable ground control station. In order to keep a Pointer UAV airborne for the duration of a typical mission, the three-man ground team is in a state of constant launch, control, and recovery. If they come under hostile fire while servicing the UAVs, launch and recoveries may be delayed or terminated until it is relatively safe to resume operations. If the system is located safely in the rear, there is insufficient flight time to get to the enemy location, survey the area, and return before the batteries run out. The Pointer is so small that increased payload size may never be possible. Advances in miniaturization are needed before additional features and functions are added to increase the capability of the vehicle. Without a night imagery capability this aircraft will have limited "real world" uses.

BQM-147A Exdrone UAV. The Exdrone system is a low-cost[7] reconnaissance unmanned aerial vehicle designed to support regiment and brigade size commands. It is a delta platform flying wing air vehicle that is five feet long and has a wingspan of eight feet, powered by a small one-cylinder, two-cycle, air-cooled engine with a two-blade propeller. The flight control system consists of a UHF uplink receiver connected to a global positioning system (GPS) based autopilot. The autopilot is a 16-bit microprocessor controlled system that provides up to five-preprogrammable waypoints. The air vehicle is gyrostabilized and capable of programmed autonomous flight. It uses microwave energy to downlink information to the ground control stations.

When tasked, the Exdrone launches from a secure area behind the FLOT. It has a launch weight of 89 pounds and a 25-pound payload capacity. It is launched by a pneumatic rail. Once airborne, the launch pilot flies the air vehicle to the cruise altitude. The vehicle service ceiling is 10,000 feet, however, the mission altitude is usually between 3,000 to 4,000 feet above ground level. It has three modes of operation: manual flight, manual override autopilot, or full autonomous.

The Exdrone began as a research and development effort to build a low-cost expendable drone capable of carrying a VHF communications jammer. The aircraft have since been modified with several different payloads to provide reconnaissance. One of the payloads is the Pulinex TM-7i down-looking color TV camera. It is a commercial-off-the-shelf color camera that provides 570 lines of resolution and a six-power zoom lens. This particular camera has a national imagery interpretability rating scale (NIRS)[8] of 4 at 3,000–4,000 feet above ground level.[9] Other payloads available include an image intensifier and forward looking infrared (FLIR) cameras.

Experimentation and testing continue for additional payloads, which include a communication jammer, communications relay, deception decoys, mine detection capabilities, and an airborne nuclear, biological, and chemical detection suite. Most of these payloads are commercial-off-the-shelf or government-off-the-shelf technologies.

An Exdrone unit consists of 10 air vehicles, two ground control stations, a pneumatic launcher, associated ground support equipment, and crew of six people. The system is small enough to be transported over land in two high mobility multipurpose wheeled vehicles (HMMWV) or flown into the theater of operations by one C-130 cargo aircraft. The 101st Airborne and 1st Cavalry Divisions currently operate the system.

Once the vehicle is launched and reaches cruise altitude, the launch pilot activates the autopilot which takes control and proceeds to the mission target area. The aircraft has a top speed of 100 miles per hour and a mission endurance of about two and one-half hours. The vehicle is controlled by the launch team if the operating area is within line of sight of the ground control station (usually about 50 kilometers). To extend operational range, a forward control team equipped with a ground control system can be positioned closer to the objective and extend the range. The Exdrone can loiter for about two hours. After reaching the target area the autopilot is programmed to loiter, fly a fixed track of way points, conduct point reconnaissance with the forward control pilot directing the flight, or conduct point reconnaissance with the launch pilot in control.

When the mission is complete the autopilot guides the aircraft to a predetermined recovery point where it is recovered by parachute.[10] If more coverage time is needed, another vehicle is launched and sent to the objective before returning the first aircraft. The ground control system can control two aircraft simultaneously.

The Exdrone has several limitations. First it has a short range because it is restricted by line-of-sight controls. Measures are needed to increase its range. Second, the UHF uplink control frequency band is often used for tactical communications. If proper frequency coordination is not made, the Exdrone can be jammed by friendly forces. If "friendly" forces can jam it unintentionally, it seems obvious that "unfriendly" forces could intentionally jam it. Finally, the aircraft has a very small payload, putting severe limitations on the amount of equipment and sensors that can be mounted on a single aircraft.

Pioneer. The Pioneer unmanned aerial vehicle was first developed for the US Navy in 1986. The system provides the operational forces with deployable tactical assets that furnishes day and night near-real-time reconnaissance, surveillance, and target acquisition, as well as battle damage assessments, artillery fire correction/adjustment of fire, and battlefield management.[11]

The Pioneer air vehicle is a short-range, remotely piloted, pusher-propeller driven, small fixed-wing aircraft that is powered by a gasoline 26.8 horsepower, two stroke, reciprocating engine. It can either be controlled remotely from a ground station or programmed to fly independently. Its primary function involves relaying video and/or telemetry information from its reconnaissance systems. However, the aircraft must be within line of sight of its ground control system at all times for positive flight control and imagery data link. It can be handed off from control station to control station, thereby increasing its range.

The aircraft is relatively small. Its wingspan is 17 feet and fuselage length is 14 feet. It weighs 450 pounds and can carry a 65–100 pound payload. Pointer will loiter on station collecting and passing data until it has finished the job or runs low on fuel. The unmanned aerial vehicle is then flown back to the recovery area where it is flown into a net or landed on a runway that has arrestment equipment capable of stopping the aircraft.

A Pioneer system consists of five air vehicles, one ground control station, a portable control station, four infrared payloads, one to four remote receiving stations, a pneumatic or rocket-assisted launcher, and a net or runway with an arrestment recovery system. The system can control two aircraft simultaneously.

A typical mission for the Pioneer lasts five hours or less. The aircraft is pneumatically launched and cruises at a speed of 185 kilometers per hour to its assigned area of responsibility. As previously mentioned, it may be passed from one control station to the next until it reaches its target area. It has a maximum altitude of 15,000 feet but usually operates lower than that to optimize its imagery capabilities. Its maximum range, with staggered control stations, is 240 kilometers.

The Pioneer was extremely successful during Desert Shield/Desert Storm. The US Army, US Navy, and US Marine Corps used it in combat. Six operational units flew more than 300 missions. Only one aircraft was shot down while three others were hit by ground fire during combat missions. Even these were safely recovered.[12]

Pioneer was highly praised as “the single most valuable intelligence collector” in the war against Iraq.[13] The US Marine Corps successfully used it to direct air strikes and provide near-real-time reconnaissance for special operations. Due to this success, investment in UAV technology has already produced the Pioneer follow-on: the Hunter.

Hunter. The Hunter is an unmanned aerial vehicle intended to provide real-time reconnaissance, target acquisition, and other military missions by flying over enemy territory and transmitting video imagery back to ground stations to inform military commanders of the enemy situation. It flies missions up to eight hours in duration, out to 150 kilometers beyond the FLOT, day or night, and in adverse weather.[14]

Each Hunter system includes eight aircraft, a launch and recovery station, a mission planning station, two ground control stations, remote video terminals, ground data terminals, assorted payloads, and sufficient vehicles and trailers to carry and power everything. The Department of Defense is currently planning to purchase 24 systems for the Army, 18 for the Navy, five for the Marine Corps, and three for training.[15] Airlift or naval shipping support would be required to transport these systems to the battle.

The Hunter concept of operations is very ambitious. According to the current plan, two air vehicles are launched from a runway that is at least 200 meters long and 75 meters wide. One vehicle is the mission aircraft while the other is a relay. The relay UAV is positioned in an orbit behind the FLOT. The mission aircraft flies to the target area and sends intelligence data to the relay vehicle. The relay aircraft then sends the intelligence data to the ground control station. The maximum altitude for both aircraft is 15,000 feet; and total loiter time cannot exceed eight hours.

This UAV is designed to accommodate numerous payloads. These payloads include a moving target indicator, an electronic intelligence (ELINT) capability, electronic countermeasures packages, the ability to act as decoys, communications intelligence (COMINT) systems, and communications jamming capabilities. Some payloads can also be modified to carry a laser designator/range finder, mine detection equipment, and nuclear, biological, and chemical sensors.

The Hunter program is in trouble and won’t be fielded in the numbers previously mentioned unless it can demonstrate logistic supportability, improved performance, and that it represents a valid joint-service effort as mandated by Congress. According to the General Accounting Office it is logistically insupportable, and tests have identified serious performance problems that adversely impact the system’s effectiveness. Its performance has not met minimum standards and may not be suitable for use by operational forces.[16] Until these shortcomings are rectified (the program management office responsible for the system has worked diligently to correct the problems), the project may be slowed or halted.

GNAT 750. The General Atomic GNAT-750 may be one of the most thoroughly field tested unmanned aerial vehicles in today's inventory. According to *Aviation Week and Space Technology* magazine, several GNAT-750 UAVs have been deployed to Bosnia, Croatia, and Albania to monitor air bases, entrenchments, supply caches and troop movements.[17] According to the article, success in the area was tempered by the need to relay data from the UAV through a manned aircraft—the RG-8 Schweitzer—that could only stay on station for about two hours at a time. Although the RG-8 has an eight-hour flight time, six of each eight hours was spent getting to and from the relay orbit sight. While the GNAT-750 has a 24–30-hour endurance, the manned relay aircraft greatly limits the overall effectiveness of the system.

The GNAT-750 is a long-endurance tactical surveillance and support system. It can fly up to 48 hours without landing for fuel. It has a service ceiling of 25,000 feet and can climb at a rate of 1,100 feet per minute. It has a wingspan of a little over 35 feet, the fuselage is 16 feet long, and its gross takeoff weight, including a 330-pound payload and gas, is 1,140 pounds.[18]

According to an article in the 11 July 1994 issue of *Aviation Week and Space Technology*, the Central Intelligence Agency would like to buy more GNAT-750s and modify half of them to act as relay aircraft. This move would allow the 24–30-hour endurance capability to pay off. The CIA would also like to modify the newer GNAT-750s with the Rotax 912 engines which have more power, are quieter, and are more fuel efficient.[19]

In addition to the electro-optics currently on the GNAT-750, David Fulghum writes in *Aviation Week and Space Technology* that he believes the CIA wants to add a signals intelligence payload to the UAV. The new sensors will pick up both communications and electronic intelligence information.[20] This would give the NATO and United Nations forces additional information from Bosnian radars and communications systems.

One concern for the GNAT-750, as well as other unmanned aerial vehicles, is its vulnerability to inclement weather.[21] For any UAV deployed to the field, measures need to be taken to protect the delicate internal electronics from dust and moisture, particularly in climates that are damp and contain sea spray. Protecting the personnel, avionics, and maintenance areas are important factors that should be considered when planning deployed operations. Portable maintenance hangars are particularly important for maintaining clean and dry work spaces for the UAV technicians.

Of the unmanned aerial vehicle programs fielded to date, the Central Intelligence Agency appears to have provided more capability for less time and money. While the Department of Defense continues to run tests, the CIA has fielded a working system that provides near-real-time information to the field commander at what appears to be a very low cost. The GNAT-750 has numerous shortcomings, but it at least has been put to work in the operational environment where it can provide real-world data while its technicians continue to work out the bugs.

Endurance Unmanned Aerial Vehicles

The endurance models of unmanned aerial vehicles are the next generation of UAVs and have tremendous potential for future operations. Their purpose is to provide near-real-time imagery to the joint task force (JTF) commander. If these aircraft can be properly designed and fielded at a reasonable cost, they will give the JTF commander an expendable, long-dwell, tactical UAV system with continuous, all-weather narrow area search capability. This class of UAV will remain on station at extended ranges for periods exceeding 24 hours. With this asset, the on-scene commander can receive direct reconnaissance, surveillance, and target acquisition information over defended hostile areas without waiting for “national assets.”[22]

This “family” of UAVs also has several prerequisites before they will be accepted and fielded. The endurance unmanned aerial vehicles must be affordable, use commercial-off-the-shelf devices, have a quick-reaction capability, and be capable of carrying payloads large enough to support a synthetic aperture radar and other imaging devices.

Medium Altitude Endurance Unmanned Aerial Vehicle Tier II Predator. The medium altitude endurance (MAE) UAV Tier II program, also known as the Predator, is designed to remain over distant battlefields, monitor enemy actions, target threats, and conduct bomb damage assessment.[23]

The Predator incorporates technological improvements pioneered by previous unmanned aerial vehicles.[24] It is powered by an 85 horsepower, four-stroke, fuel injected reciprocating Rotax engine with a variable pitch propeller. Unlike most unmanned aerial vehicles, the Predator is not restricted to direct line-of-sight data transmission. The flight control system consists of a UHF uplink receiver connected to a global positioning system and inertial navigation system. This system is relayed through a Ku-band, 1.5 Mbps satellite communications systems (SATCOM). It uses a line-of-sight data link for takeoff and landing. The aircraft operating range is greater than 500 nautical miles (more than 930 kilometers) because the SATCOM allows the aircraft to fly either through direct control or autonomously.

The Predator wingspan is over 48 feet and the fuselage is over 26 feet in length. Its maximum takeoff weight is 1,873 pounds. This includes 650 pounds of fuel and a 450-pound payload. It has a maximum altitude of 25,000 feet, can stay airborne over 24 hours, and flies at speeds of 70–130 nautical miles per hour. It can be transported in one C-141 cargo aircraft or multiple C-130 aircraft and can be made operational within six hours of arrival, assuming it has a runway for takeoff.

Projected payloads include the Versatron Corporation Skyball multipayload electro-optical sensor. This surveillance system has a platinum silicide staring array infrared imager with six field of view optics. This provides

TV-like images in visibility conditions ranging from full daylight to total darkness. It also has a high resolution color CCD daylight television camera with a 10-power zoom capability, a "spotter scope," and an eye-safe laser range finder.[25] Other sensors include additional optics capabilities and a synthetic aperture radar capable of one-foot resolution at 15,000 feet. The sensors used on the Predator produce releasable, unclassified products and does not compromise sensitive technology if lost over enemy territory.[26]

Current plans call for 10 aircraft and three ground stations. All 10 will be delivered with an electro-optical/infrared payload and a Magnavox UHF satellite data link. Modifications will be made, after delivery, to install Westinghouse SAR and Unisys Ku-band satellite data links. At $3–$5 million per aircraft, the Department of Defense hopes to field a system of unmanned aerial vehicles that can provide "eyes on target" for the JTF commander 24 hours a day, regardless of the weather.

High-Altitude Endurance (HAE) UAV Tier II Plus. The program goal of the HAE UAV is to develop and demonstrate a long dwell UAV system capable of affordable, continuous, all weather, wide area surveillance in support of military operations.[27] Two complementary UAV systems are being developed under this program; a low observable HAE (Tier III Minus) and a conventional design HAE (Tier II Plus). The object is to get a "satellite like" surveillance and reconnaissance capability in the hands of the theater commander so direct operational control and tasking can be made by the war fighters.

The Tier II Plus air vehicle should be capable of sustained high-altitude surveillance and reconnaissance. It will operate at ranges of up to 3,000 nautical miles from its launch area. Once launched, it should have the capability to loiter over the target area for 24 hours at an altitude greater than 60,000 feet.[28]

The Tier II Plus system is composed of three segments: air, ground, and support. The air vehicle segment consists of air vehicles, sensor payloads, avionics, and line-of-sight and satellite communications data links. The ground segment consists of a launch and recovery element, a mission control element, and a ground communications element. There is also a support segment and the operating personnel. All of these segments are the same for both the Tier II Plus and Tier III Minus systems.[29]

The Tier II Plus will carry electro-optical, infrared, and synthetic aperture radar sensors that will include a ground moving target indicator (GMTI). This UAV is linked to the ground control station and theater commander by line-of-sight or satellite relay communications. The air vehicle will be capable of fully autonomous takeoff, flight, and recovery. There is no need for a person to remotely fly the aircraft; however, it is capable of inflight route and mission-tasking changes, allowing it to be dynamically retasked at any time by the mission control element. If the uplink control communications is lost at any time, the aircraft is programmed to automatically return to the base from which it was launched.[30]

This program is subject to numerous changes. One of the key factors of the program is its cost. The DARO investment strategy mandates that the program must obtain the maximum capability possible for a set, nonwaiverable unit flyaway price of $10 million per aircraft.[31] This price includes the airframe, avionics, payload, and airborne data link elements. The ground segment components, personnel, training, maintenance and logistics costs are not included in the $10 million limitation. Therefore, this program will change as it becomes constrained by fiscal limitations.

Low Observable High-Altitude Endurance UAV Tier III Minus. The Tier III Minus is a complementary high-altitude endurance unmanned aerial vehicle with low observable technology features. The exact capabilities are still classified, but this vehicle will be capable of sustained high-altitude surveillance and reconnaissance over and into high threat areas. It will operate at ranges in excess of 500 nautical miles from the launch area and be able to loiter over the target area for more than eight hours at an altitude in excess of 45,000 feet. This UAV will carry either electro-optical or synthetic aperture radar sensors. This aircraft will employ both wideband line-of-sight and moderate bandwidth satellite communications.[32] See table 2 for a summary of the three tier programs.

Table 2

Endurance UAV Capabilities/Relationships

Capability	**MAE UAV** (Tier II)	**HAE UAV** (Tier II plus)	**LO HAE UAV** (Tier III Minus)
Status	On Contract	Phase I On Contract	On Contract
Endurance	>30 hours	>40 hours	>8 hours
Altitude	25,000 feet	65,000 feet	>40,000 feet
Airspeed	125 knots	350 knots	>250 knots
Payload	450 pounds	1,500 pounds	>500 pounds
Sensors	SAR and EO/IR (limited capability)	SAR and EO/IR	Either SAR or EO
Data Link	CDL COMSAT 1.5 Mbits/sec	CDL COMSAT 10–50 Mbits/sec	CDL COMSAT 1.5 Mbits/sec
Reduced Observables	No	No	Yes

Source: Defense Airborne Reconnaissance Office (DARO) briefing presented to the Association for Unmanned Vehicle Systems, 24 January 1995.

Emerging and Enabling Technologies

There are several types of UAVs that are still in prototype stages. Due to the scope and size of this study, these will only be briefly mentioned. Since most are still experimental and not operationally available, size, shape, and payloads may change over time. The significance of these prototype systems is not the product itself but the emerging UAV technologies that they demonstrate.

The tilt wing/rotor UAV System (TRUS) is being developed to offer a combination of rotary- and fixed-wing technologies. It provides a vertical takeoff and landing capability, as well as the ability to hover. It provides a mix of speeds that are slower than fixed-wing aircraft and has cruise and dash speeds which exceed conventional rotary-wing aircraft.

Vertical launch and recovery systems include numerous experimental combinations of lift and propulsion. Included in this group are ducted fan, jet lift, vertical altitude, stopped rotor, conventional helicopter, as well as tilt rotor aircraft. The requirements for this program include the ability for unassisted vertical takeoff and landings. They must also be capable of maintaining controlled hover for a minimum of three minutes in a zero knot wind condition. The program hopes to achieve a 200-pound payload, five hours' endurance, a 10,000-feet service ceiling, and speeds of at least 150 nautical miles per hour.

The Bell Eagle Eye is a combination tilt wing/rotor vertical takeoff and landing UAV. It is powered by an Allison 250-C20B heavy fuel engine capable of speeds from 0 to 220 knots. It has a service ceiling of 20,000 feet and can fly for over more than two hours. This aircraft will be equipped with a variety of multimission payloads including TV, FLIR, radar, electronic countermeasures, data relay, and a laser designator. This UAV is scheduled to become operational in the late nineties.[33]

The United States Navy wants a small maritimized vertical takeoff and landing UAV for use on board small naval combatant ships. Known as MAVUS, this technology has been used to demonstrate automated launch and recovery techniques on board ships at sea. Naval officials hope the MAVUS will eventually provide covert high resolution coastal surveillance in support of amphibious operations. The Navy wants a system that will also provide visual identification of ships without exposing or risking friendly surface ships and helicopters. These aircraft will eventually provide over-the-horizon surveillance and target classification, allowing the naval commander to position forces and target the enemy without risking manned assets.

Many aspects of UAV development depends on surpassing limitations caused by inadequate equipment and technologies. Some of the primary areas needing further development include propulsion systems, vehicle control and management, airframe development and construction, data link vulnerabilities, communications, mission sensor payloads, mobility and transportability, and aircraft survivability systems.

The most critical aspect of producing effective and dependable UAVs is engineering flight control redundancies that allow the aircraft to operate autonomously and return to its original base if the data link control signal is severed or jammed. Most aircraft are using a common data link used for transferring signals and imagery intelligence.[34]

The Tier II Plus and Tier III Minus vehicle command, control, and communications area implemented using either Intelsat satellites or one or more of the space-based, cellular satellite systems is expected to be operational by 1998. Program managers hope diversity and the hesitancy to jam multinational, commercial communications provides adequate antijam capabilities.[35]

Due to the current state of technologies, there is no way to avoid enemy intercept of global communications. Although the enemy can't be stopped from intercepting transmissions, exploitation is denied using encryption. UAV to UAV relay is also a possibility for extending line-of-sight operations, but this increases risk and costs because you have to depend on getting more than one UAV airborne and operating at all times. If the developers of the various systems decide to "harden" the data links, the much more expensive but jam resistant solution is the Milstar II satellites.[36]

This state-of-the-art UAV overview was designed to give the reader the background from which to fairly evaluate UAVs as one of several options available to satisfy SOF capability deficiencies highlighted in chapter 2. A comparative analysis of UAVs and alternatives is presented in the next chapter.

Notes

1. This definition is a combination of the one used by Air Chief Marshal Sir Michael Armitage, KCB, CBE, RAF, *Unmanned Aircraft* (London: Brassey's Defence Publishers, 1988), xi; and the definition found in the Department of Defense, Deputy Under Secretary of Defense (Advanced Technology) document titled, "Unmanned Aerial Vehicles (UAV) Program Plan," Washington, D.C.: Defense Airborne Reconnaissance Office (DARO), April 1994, A-2.

2. Armitage, xi–xii.

3. Ibid., and "UAV Program Plan," A-1.

4. Headquarters Air Force Special Operations Command/XPP, Air Force Modernization, Mission Area Plan, "Joint Air-SOF Battlefield Interface," 1 December 1993, 52.

5. All data pertaining to the Pointer hand launched UAV and the BQM-147A Exdrone were provided by the Department of Defense, Program Executive Office, Cruise Missile Project and Unmanned Aerial Vehicle Joint Project, and the DARO. All information is unclassified. Conclusions and inferences made are my own and do not reflect the opinion or policy of either of these organizations.

6. The cost for a Pointer, not including the ground support equipment, is approximately $20,000 per UAV.

7. The cost for an Exdrone, not including the ground support equipment, is approximately $25,000 per UAV.

8. The NIRS is a scale used by imagery analysts to determine imagery definition. The more detail per square foot at high altitude, the higher the NIRS rating.

9. Test was performed at Dugway Proving Ground in March 1994. Source is DOD "UAV 1994 Master Plan," 3-23.

10. Prior to using a recovery parachute, units were taught to land the air vehicle with "stick and rudder." This procedure caused an unacceptable attrition rate. Since using a commercial parachute, attrition has been cut significantly.

11. All data pertaining to the Pioneer was provided by the Department of Defense, Program Executive Office, Cruise Missile Project and Unmanned Aerial Vehicle Joint Project, and the DARO. All information is unclassified. Conclusions and inferences made are my own and do not reflect the opinion or policy of either of these organizations.

12. DOD, "UAV 1994 Master Plan," 31 May 1994, 3-9.

13. Lt Gen Boomer, Marine Corps Central Command Element Headquarters (MARCENT).

14. "UAV 1994 Master Plan," 3-2.

15. US General Accounting Office, "Unmanned Aerial Vehicles: No More Hunter Systems Should Be Bought Until Problems Are Fixed," March 1995, 2.

16. Ibid., 4–12.

17. David A. Fulghum, "CIA to Fly Missions from Inside Croatia," *Aviation Week and Space Technology*, 11 July 1994, 20; and Bill Sweetman, "Drones Invented and Forgotten," *Popular Science*, September 1994, 34.

18. Aircraft data provided by General Atomics Aeronautical Systems, 10130 Sorrento Valley Road, San Diego, California, 92121.

19. Ibid., 21.

20. Ibid.

21. Sweetman, 34.

22. "DARO UAV Program Plan, April 1994," 6-1–6-3.

23. Gerald Green, "Washington Perspective," *Unmanned Systems*, Summer 1994, 42.

24. Data pertaining to the "MAE UAV" was provided by the Department of Defense, Program Executive Office, Cruise Missile Project and Unmanned Aerial Vehicle Joint Project, and the DARO. All information is unclassified. Conclusions and inferences made are my own and do not reflect the opinion or policy of either of these organizations.

25. "Skyball, The Eyes for Predator," *Unmanned Systems*, Fall 1994, 30–31.

26. Capt Allan Rutherford, USN, "Medium Altitude Endurance," *Unmanned Systems*, Spring 1994, 18–19.

27. John Entzminger, director, Advanced Research Projects Agency, Unmanned Aerial Vehicles Joint Project Office, briefing, Association for Unmanned Vehicle Systems Winter Roundtable, 24 January 1995.

28. Advanced Research Project Agency, "High Altitude Endurance (HAE) Unmanned Aerial Vehicle (UAV) Concept of Operations," draft, version 2.1, 10 February 1995, 1-1–1-6.

29. Ibid., 2-5.

30. Ibid.

31. Ibid., 1-1.

32. Ibid., 1-1–2-6.

33. Chuck H. Jacobus, Bell Helicopter Textron, Fort Worth, Texas.

34. "UAV 1994 Master Plan," 5-7.

35. Loral/Boeing, High-Altitude Long Endurance Unmanned Aerial Vehicle Systems, "Alternative Operational Concepts and Mission Payloads, Discussion Outline," 4–5.

36. Ibid., 5.

Chapter 4

Analysis and Conclusion

There are no whole truths; all truths are half-truths. It is trying to treat them as whole truths that plays the devil.

—Alfred North Whitehead

The truth of the matter is that in place of the cold war framework, there are now new dangers which fall into four broad categories: (1) Dangers posed by nuclear weapons and other weapons of mass destruction. This area includes the dangers associated with the proliferation of nuclear, biological, and chemical weapons. (2) Regional dangers posed by major regional powers seeking hegemony that is counter to US interests. (3) Dangers to democracy and reform in the former Soviet Union, Eastern Europe, and elsewhere. (4) Economic dangers to the United States by competitive world traders fighting for market share in areas normally dominated by the US economy.[1]

In light of the cold war changes and emerging new dangers, special operations forces provide combatant commanders unique capabilities to fight enemies of the United States of America. On the very first mission of Desert Storm, special operations forces employing sophisticated navigation equipment, specialized flying techniques, and their own "stealth" capability raided Iraqi early warning and ground control intercept sites. This freed the USAF F-117s, originally slated to target Iraqi early warning radars, to strike higher priority targets in Baghdad.[2]

The key to effective special operations is getting the right people, to the right place, performing the task, and returning safely without being detected or harmed. In order to accomplish these tasks, they need equipment that is sufficiently versatile and reliable.

To ensure the right equipment for the job is acquired, United States Special Operations Command (USSOCOM) has identified deficiencies and examined nonmaterial solutions. For those cases where changes in doctrine, tactics, or training fail to resolve the deficiency, then the research and development community is called upon for assistance.[3]

The USSOCOM and the special operations component commanders have enumerated their capability deficiencies and the 11 technology development objectives—listed in priority order in the previous chapter—which show several areas where they have deficiencies in war-fighting capability. They have numerous requirements for improved equipment and mission enhancement. Some of these areas include command, control, communications and intelligence (C^3I), navigation subsystems, aircrew-vehicle interface subsystems, defensive subsystems, sensors/fire control subsystems, armament subsystems, air vehicle subsystems, power generation subsystems, logistics support systems, intelligence support systems, mission planning/rehearsal support systems, training support systems, and personnel/life support systems.[4] Of the eleven listed technology development objectives, unmanned aerial vehicle technologies may have a positive effect on eight of the areas.

Due to the scope of this study, the focus of this comparative analysis only includes three capability deficiencies and the corresponding technology development objectives that may warrant a UAV material solution. Problems like upgrading the weapons on AC-130 Gunship aircraft, improved avionics for MH-53J Pave Low helicopters, and improved weapons for direct action teams have no applicability to unmanned aircraft. Because of this, in this chapter I examine only SOF deficiencies and TDOs which might have a UAV solution.

Timely Intelligence Deficiency

The most prevalent capability deficiency in the special operations community is a lack of timely intelligence. Effective intelligence must assist commanders in identifying special operations objectives that support the overall theater objectives. All aspects of military operations are dependent on the determination of relevant, clear, and attainable objectives. Intelligence should provide the commander with an understanding of the enemy in terms of their goals, objectives, strengths, weaknesses, values, and critical vulnerabilities.[5]

A great deal of information is available to commanders through service and national intelligence organizations. Special operations usually need "target specific" intelligence that requires more research, analysis, graphics, photos, and textual elaboration.[6]

Added to the complexity and demand for information is that special operations tasking often occurs very fast. Urgent, short-notice missions are not unusual. Therefore the intelligence system "feeding" the commander and planners must be flexible enough to satisfy both time-sensitive and deliberate mission planning processes. Additionally, intelligence requirements and operational security (OPSEC) should be considered carefully to ensure that adequate information can be gathered without compromising the mission or the location of the participants.

Given these criteria for detailed, target specific, fast, and secure intelligence, USSOCOM has listed intelligence as a deficiency because they cannot receive "real/near-real-time imagery from national systems," and "no real-time interface between aircraft and teams to Intel (sic) systems." They have also determined that there is "no automatic en route threat replan" capability, and "no all source threat location data." There is also "no real-time imagery for target study."[7] Every aspect of special operations is affected, good or bad, based on how fast and accurately it receives intelligence information.

Three of the eleven USSOCOM technology development objectives, ask for technologies that would assist the intelligence community. Finding technologies for detecting and classifying weapons of mass destruction, detecting passive shallow water and terrestrial mines, explosives, and booby traps are high on the priority list. The special operations people also want to find technologies that locate, track, and mark targets, as well as advanced vision devices and sensors.[8]

According to various USSOCOM documents, their solution to the problem is, "field deployable imagery systems for Joint Force Commanders and his (sic) components." The "Joint Air-SOF Battlefield Interface," and "Force Application" deficiency/solution matrices recommend special operations forces field the multimission advanced tactical terminal (MATT)[9] and the Quiet Knight technologies.[10] Both programs are specifically designed to provide enhanced situational awareness to special operators by exploiting enemy communications and by manipulating tactical and national intelligence data. Through these programs mission planners gain access to real-time imagery, an aircraft interface capability, and an en route threat replan capability.[11] The "Force Application" matrix also recommends fielding a capability to get all-source data, and real-time imagery hardware and software.[12] What does all this mean?

Essentially, no one on the ground or in the air is getting real/near-real-time visual information. As a hypothetical example, a special reconnaissance team is observing a nuclear weapons production facility in a country hostile to the United States. The team is concealed and has been observing the facility 24 hours a day for the last three days. Their only contact with their military leaders is through a secure, UHF satellite communications radio. They have no way of passing visual information. They can speak into the radio and describe what they see. Each time they "key" the microphone on the radio to transmit a message, they endanger themselves by electronically giving away their position[13] or by being overheard by someone nearby. These people provide the "eyes and ears" to the commander but are limited in how they can communicate what they observe.

On the positive side, they can remain in place as long as necessary and provide 24-hour observation regardless of weather conditions. Their stay is only limited by food, water, and being discovered. On the negative side, they have limited means for communicating what they see and hear to their command authorities. Without some means of resupply, they are unable to observe the area beyond 72 hours. After that length of time, they are low on food, water, and batteries for their equipment. The longer they stay, the greater the risk of being discovered.

Another situation where real-time information is crucial is during direct action operations. If hostages are being rescued or a sensitive target is being "taken down," the commander and men about to attack want the most current on-scene information available. If the enemy situation changes and the attacking forces are unaware of new developments, careful planning and rehearsal can quickly be overcome by events that were not planned for. The previously mentioned Son Tay raid is only one example of "perishable" intelligence. A simple thing like changing guards at a different time, or the arrival of fresh troops or hostages, can all add "fog and friction" to an environment full of uncertainty.

Could an unmanned aerial vehicle be useful in providing necessary intelligence for a situation like this? Currently, no. Sensitive surveillance, as described in the previous example, needs to be unobserved and unheard. The tactical UAVs discussed in chapter 3 have numerous limitations that preclude them from current consideration. Range, payload size, and endurance lead the list of limitations. The hypothetical special reconnaissance team is deep in hostile territory. The closest "friendly" nation that would allow the United States to operate from its territory is in all probability, hundreds of miles away. Naval-based assets are also limited by distance. Therefore, none of the tactical UAVs are useful for this type of mission.

If, on the other hand, certain innovations could be achieved, then UAVs might support, reduce, or even eliminate the need for the special reconnaissance team. If the Exdrone or the Pointer could be more logistically supportable—small enough that the team could parachute into hostile territory and carry everything they need to launch and recover a few UAVs—then its use might be practical. The team could conceal itself farther from the facility they are observing and have less chance of being discovered. They could then launch a UAV which loiters over the facility at an altitude high enough to remain unseen and unheard. Ideally, such a UAV would also be capable of sending real-time video imagery to the special reconnaissance team and to a satellite for relay to higher echelons. Currently, this suggested scenario is science fiction. None of the UAVs are small enough, flexible enough, or capable enough to assist the manned teams on the ground.[14]

A potential solution available within the next five years is the Tier II Plus medium altitude endurance UAV, which has characteristics that might replace the need for risking a team on the ground. When the Tier II Plus is fully operational it can orbit at 20,000–25,000 feet for 24 hours at a time, and send, via satellite communications, high resolution real/near-real-time electro-optical, infrared, and synthetic aperture radar imagery to a ground control station near the joint force commander's headquarters.

If the scientists and engineers developing this system can make it dependable enough, then UAVs may in some circumstances replace teams on the ground. There would need to be a sufficient number of air vehicles available to provide continuous coverage for as long as necessary, and the sensors would have to operate in all levels of environmental and meteorological conditions. Using these assets to augment a team in the field is more likely than replacing the team. The value of the information will determine the level of effort put forth by both manned and unmanned assets.

There are numerous special operations scenarios where 24-hour visual surveillance of a target or potential target is extremely useful. Dependable real-time imagery of suspected terrorists compounds, weapons of mass destruction facilities, and drug traffickers' movements and activities are just a few examples where real-time intelligence would help special operations planners and war fighters accomplish their missions. But for the systems to be useful to special operators they must be very portable, easy to conceal, and require very little logistical support. The system has to be small enough for a team to carry without overburdening them with weight. If the UAVs can't be made small enough, then aircraft that are large enough and can operate at high altitudes over long distances are the best direction to follow when looking for an unmanned aircraft that can support special operations needs.

Communications Deficiency

Another special operations forces deficiency is command, control, and communications (C^3). USSOCOM and its components have a mix of communications subsystems that are not always compatible nor interoperable. Communication systems for special operations must be jointly interoperable, reliable, secure, redundant, lightweight, flexible, highly mobile and should provide low probability of intercept/detection (LPI/D). They must be capable of furnishing weather and intelligence information (data, imagery, and/or narrative) to all levels of the command. These systems must be time-sensitive for direct action, counterterrorism, and special reconnaissance missions where direct contact with the highest tasking authority is required.[15]

Special operations forces often use space-based systems for both tactical and long-range communications. Because these forces operate at all levels and spectrums of conflict, they must be able to communicate with a very diverse group of communication systems. The SOF communications criteria boil down to secure, reliable, interservice and intraservice communications connectivity capabilities, down to the team, squad, and aircrew levels.[16]

Encompassed within the communications deficiency, USSOCOM has listed several deficiencies in both the "Joint Air-SOF Battlefield Interface," and the "Force Application," and "Psyops" deficiency/solution matrices. The deficiencies include "limited accessibility, coverage, bandwidth, size, weight"; a "lack of standardized equipment and procedures"; as well as "potential for enemy to monitor or destroy our information systems." There is also a concern for "inconsistent theater command and control for special operations forces." Some of the other deficiencies include "limited SATCOM capability," and that the "SATCOM is jammable and spoofable." They are also disturbed by the fact that "no aircraft are low probability of intercept or low probability of detection capable."[17] The "USSOCOM Technology Development Objectives," has "improved communications systems," listed as their fifth priority out of 11 technology areas needing improvement.[18]

To solve this deficiency, the special operations community is trying to acquire more satellites, better radios, procure common systems, develop counter-countermeasures, and field low probability of intercept/low probability of detection radios.[19] This will be extremely costly and take several years to implement, and given that these systems only address some, and not all of the

SOF communications criteria. This modernization program will soak up a lot of resources that might be used for other pressing requirements.

One solution special operations has not considered extensively is funding unmanned aerial vehicles as communications platforms and relays. As described by Doctors Will and Pelton in their article on high-altitude long endurance UAVs, a UAV at 13 miles in altitude can be used as a “poor man’s satellite.”[20] Geostationary satellites require funding of up to $250 million, a “13-mile” UAV could cost as little as $10 million for an entire system’s operation and spare platforms.[21] At a regional level, these UAVs could offer the same capabilities as satellites at a greatly reduced cost.

High-altitude, long-endurance unmanned aerial vehicles are being developed to meet this need. Because of the spread of cellular telephones many developing nations are looking at satellites and UAVs for communications instead of laying miles and miles of telephone wire. A UAV at 13 miles altitude can receive radio communications from earth and redirect them within a 300-mile diameter. This actually services an area with a diameter of 181,000 square kilometers. Thus, it acts like a low-cost, low-orbit geosynchronous satellite.[22]

The psychological operations community have considered such a relay platform. The EC-130 Volant Solo and Commando Solo aircraft perform the task of airborne broadcast services. These aircraft receive, analyze, and transmit various electronic signals in order to exploit the electromagnetic spectrum for psychological operations. They can broadcast in AM and FM radio, short-wave, television, and military command, control, and communications frequencies and channels.[23]

But both of these airborne platforms are limited by range and power. This coupled with the saturation of satellite communications systems may open a window of opportunity for UAVs.[24] According to Headquarters Air Force Special Operations Command,

> a space-based system or remotely piloted vehicle (UAV) which could relay or reflect transmissions from ground sources would also be much cheaper and would involve less risk than an aircraft capability. A space-based (or UAV) system could also be employed easier and perhaps faster than the requisite number of aircraft. A direct transmission capability would save the time and effort of getting recorded material to the aircraft, would permit PSYOP Commanders in theater to be much more current in their propaganda, and could provide more responsive coverage.[25]

In addition, the Air Force Special Tactics Teams need an enhanced capability to conduct local weather observations and the ability to access the global weather network via satellite (or other communications) and computer modem. They need to do this from a deployed location to update the theater weather forecast.[26] A communications UAV tied into the worldwide weather service network could provide information feeds to numerous squads and missions, simultaneously, without increasing cost or complexity to the overall communications architecture.

Is there a high-altitude long-endurance UAV currently available that meets the requirements? No. Again, this concept is still on the drawing board, awaiting technologies and funding to catch up with what is needed in the field. There are plans for this type of UAV, but no one knows when it will become operable and fully mission capable.[27]

Resupply Deficiency

Another stated need is a means to carry a payload large enough to drop printed products (leaflets) or resupply special operations teams on the ground or at sea. USSOCOM has a validated "Mission Need Statement for Psychological Operations Unmanned Aerial Vehicle Payloads (UAV-P)," which asks for the capability to deliver a minimum of 200 pounds of leaflets with a point accuracy of 200 meters.[28] This is considered a critical need because there are no other assets in the US inventory that can deliver leaflets over a high-risk area without endangering aircrews.

The Navy sea-air-land teams, Army special forces, and Air Force special tactics teams also have a requirement for being resupplied. Expendable supplies like batteries, food, water, medical materials, and ammunition need to be replenished when forces are in the field. Rapid employments to forward areas are conducted using battery-powered equipment for communications, navigation, and other tasks. These highly trained teams normally deploy with a 72-hour supply of equipment. If the teams have to stay deployed for extended periods of time they need to be resupplied.

Currently, the only means available for resupplying these teams in the field is by helicopter or airdrop. Both of these delivery systems expose the aircrews and teams on the ground. An unmanned aerial system capable of arriving undetected during hours of darkness would greatly enhance the survivability of the forces on the ground and extend the length of their operations.

There exists a need for resupplying or delivering supplies/leaflets accurately without unduly endangering aircrews or the teams on the ground. Is there a UAV that can deploy 200 or more pounds of payload? No. None of the previously mentioned UAVs are capable of supporting this requirement. The Tier II Plus is currently the best candidate for meeting the resupply/leaflet drop capability deficiency. Again, this system is in development with no definite date for actual deployment.

These are but a few of the many special operations deficiencies that unmanned aerial vehicles might someday resolve. However, until the time comes when these systems are fielded and proven reliable, the special operators will have to continue using skill and ingenuity to reduce the risk they face accomplishing their mission.

Conclusions

Special operations forces need the capabilities that unmanned aerial vehicles offer. The payloads that can be uploaded and sent aloft can dramatically improve special operation's ability to perform many missions and tasks. Long loiter times and high resolution sensors providing surveillance and reconnaissance can greatly reduce the number of missions where people on the ground are exposed to danger. HALE UAVs can improve command, control, and communications deficiencies by acting as “13 mile” high relay platforms that replace more expensive satellites. UAVs with cargo-carrying capacity can deliver food, water, or leaflets to areas of the world which were previously inaccessible or too dangerous to fly over.

As previously stated, there is a significant intelligence deficiency that can be solved by real-time video furnished around-the-clock by unmanned aerial vehicles. Special Operations Forces need target specific intelligence that requires more research, analysis, graphics, photos, and textual elaboration. It must be fast, and the information source cannot disclose the ground team's location. The UAV “concept” can provide these capabilities to the war fighter.

Another deficiency UAVs can solve is the current inadequate communications capability hindering special operations. As previously presented, SOF needs a secure, reliable, interservice and intraservice communications connectivity capability that reaches down to squad and aircrew levels. High-altitude relay unmanned aerial vehicles provide a cost-effective means for extending the range and capability of current and future communication systems. The ability to rapidly change components of the UAV payload to adjust to the dynamic communications environment allows special operators to install and update low probability of intercept and low probability of detection technologies at much lower costs than switching out the “black boxes” on a satellite. UAVs can greatly extend the communications capability of special operations teams working the land and sea environments by providing secure, low-cost systems that directly support the war fighter.

The final capability deficiency, the “resupply” dilemma may, in some ways, be solved or assisted by unmanned aerial vehicle technologies. The psychological operations community has already determined the need for an unmanned system to deliver information over areas too dangerous to fly a manned platform. They have seen the wisdom of using technology to “go where no man wants to go.” Dropping information leaflets over hostile territory without endangering US personnel seems like an extremely reasonable approach. If 200 pounds of leaflets can be accurately dropped, then 200 pounds of food, water, and expendable supplies can also be precisely dropped to special operations teams in the field. Resupplying teams in hostile or isolated regions of the globe without endangering aircrews is a worthwhile pursuit. Therefore, continued efforts toward developing reliable UAVs are important to the special operations community.

The concept of unmanned aerial vehicles seem to answer many of the special operations capability deficiencies. However, none of the current configurations come close to meeting SOF's unique needs. They have the potential for performing a multitude of surveillance and reconnaissance missions, for acting as communications relay platforms, and for delivering payloads large enough to resupply forces or drop leaflets. However, currently there are no UAVs in production that can reliably correct any of the SOF deficiencies to the degree of reliability needed. Each system, although striving to improve, fails to deliver sufficient endurance, reliability, maintainability, and sensor connectivity to help special operators see, hear, and resupply their battlefield better.

The Department of Defense and civilian contractors are trying to field systems that work for the war fighters. But until the technology and integration of systems is mature and dependable, the concept of UAVs complementing SOF capability will be "later" instead of "sooner."

Notes

1. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Aviation Foreign Internal Defense," 1 December 1993, 5.

2. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Joint Air-SOF Battlefield Interface," 1 December 1993, 27.

3. Ibid., 1–3.

4. Compiled from numerous "Mission Area Plans," "Mission Need Statements," "Operational Requirements Documents," and USSOCOM memorandums and documents.

5. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Joint Air-SOF Battlefield Interface," 30–31.

6. Ibid., 31.

7. Ibid., 36, and Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 1 December 1993, 34.

8. USSOCOM Memorandum, 3 November 1994, "Subject: USSOCOM's Technology Development Objectives (TDOs)," signed by Gen Wayne A. Downing, USA.

9. MATT is a miniaturized airborne qualified UHF receiver providing near real-time, over-the-horizon threat data directly to the war fighter at the secret level. This terminal can simultaneously receive and process intelligence reports from the Tactical Receive Applications (TRAP), Tactical Data Exchange System Broadcast (TADIX-B), and Tactical Information Broadcast Service (TIBS). Information provided by AlliedSignal Inc., Baltimore, Maryland.

10. Information provided by AlliedSignal Inc., Baltimore, Maryland.

11. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 37.

12. Ibid., 34.

13. Most countries with modern weapons have direction-finding equipment that locates unauthorized radio transmissions. The Iraqis located some of our downed pilots in this way.

14. After examining specifications and data on all of the UAVs currently available, none of the systems have sufficient range, endurance, or compact logistics packages capable of helping special forces teams. Each system needs support that is too cumbersome or limited to meet current SOF requirements.

15. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Joint Air-SOF Battlefield Interface," 32, and Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 47.

16. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Joint Air-SOF Battlefield Interface," 32–33.

17. Ibid., 36; Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 34; and Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Psychological Operations (PSYOP)," 1 December 1993, 28.

18. USSOCOM Memorandum, 3 November 1994, "Subject: USSOCOM's Technology Development Objectives (TDOs)," signed by Gen Wayne A. Downing, USA.

19. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Joint Air-SOF Battlefield Interface," 36; Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 34; and Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Psychological Operations (PSYOP)," 28.

20. Thomas E. Will, PhD, and Joseph N. Pelton, PhD, "Hail HALE, The Answers May All Be Here," *Unmanned Systems*, Winter 1995, 31–34.

21. Ibid., 31.

22. Ibid., 33–34.

23. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Psychological Operations (PSYOP)," 20–21.

24. Ibid., 29.

25. Ibid., 42.

26. Headquarters Air Force Special Operations Command/XPP, "Air Force Modernization Plan, Mission Area Plan: Force Application," 51.

27. Department of Defense, "Unmanned Aerial Vehicles 1994 Master Plan," 31 May 1994.

28. USSOCOM, "Mission Need Statement (MNS) for Psychological Operations Unmanned Aerial Vehicle Payloads (UAV-P)," USASOC 92-134, 31 October 1994.

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