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MASTER OF MILITARY STUDIES

UNMANNED AERIAL VEHICLES – THE KEY TO EFFECTIVE SITUATIONAL AWARENESS IN LITTORAL OPERATIONS

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Abstract
This paper describes the Vital Role Unmanned Aerial Vehicles (UAV) should play in providing much needed "Eye in the Sky" situational awareness to Amphibious Ready Group (ARG) Marine Corps Expeditionary Unit (MEU) operations in highly challenging littoral environments. The arguement is made that this UAV surveillance capability must be organic to argimeu units to ensure timely and comprehensive implementation contributing to effective local battlespace dominance and force protection. An historical examination of UAV use in littoral operations by the U.S. Armed Forces is made to illustrate that an effective, reliable UAV system tailored for ARGIMEU use is long overdue. Advances in current surveillance technology are described that should be considered for incorporation in UAV programs supporting amphibious operations. The arguement is made that Long-Dwell UAV flight endurance is vital in providing the level of surveillance necessary to fully support amphibious operations. The endurance of "Firescout" - The Navy/Marine Corps vertical takeoff and landing UAV (VTUAV) Program competition winner, currently scheduled to "Replace" the troubled pioneer UAV beginning in 2003, places it in the category of an interim answer to the Long-Dwell surveillance requirement.

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THIS PAPER DESCRIBES THE VITAL ROLE UNMANNED AERIAL VEHICLES (UAV) SHOULD PLAY IN PROVIDING MUCH NEEDED "EYE IN THE SKY" SITUATIONAL AWARENESS TO AMPHIBIOUS READY GROUP (ARG) / MARINE CORPS EXPEDITIONARY UNIT (MEU) OPERATIONS IN HIGHLY CHALLENGING LITTORAL ENVIRONMENTS. THE ARGUMENT IS MADE THAT THIS UAV SURVEILLANCE CAPABILITY MUST BE ORGANIC TO ARG/MEU UNITS TO ENSURE TIMELY AND COMPREHENSIVE IMPLEMENTATION CONTRIBUTING TO EFFECTIVE LOCAL BATTLESPACE DOMINANCE AND FORCE PROTECTION.

AN HISTORICAL EXAMINATION OF UAV USE IN LITTORAL OPERATIONS BY THE U.S. ARMED FORCES IS MADE TO ILLUSTRATE THAT AN EFFECTIVE, RELIABLE UAV SYSTEM TAILORED FOR ARG/MEU USE IS LONG OVERDUE. ADVANCES IN CURRENT SURVEILLANCE TECHNOLOGY ARE DESCRIBED THAT SHOULD BE CONSIDERED FOR INCORPORATION IN UAV PROGRAMS SUPPORTING AMPHIBIOUS OPERATIONS.

THE ARGUMENT IS MADE THAT LONG-DWELL UAV FLIGHT ENDURANCE IS VITAL IN PROVIDING THE LEVEL OF SURVEILLANCE NECESSARY TO FULLY SUPPORT AMPHIBIOUS OPERATIONS. THE ENDURANCE OF "FIRESCOUT" - THE NAVY/MARINE CORPS VERTICAL TAKEOFF AND LANDING UAV (VTUAV) PROGRAM COMPETITION WINNER, CURRENTLY SCHEDULED TO "REPLACE" THE TROUBLED PIONEER UAV BEGINNING IN 2003, PLACES IT IN THE CATEGORY OF AN INTERIM ANSWER TO THE LONG-DWELL SURVEILLANCE REQUIREMENT.

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DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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EXECUTIVE SUMMARY

Title: Unmanned Aerial Vehicles – The Key to Effective Situational Awareness In Littoral Operations

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Thesis: At present, the capability for normally-deployed Amphibious Ready Groups (ARGs) to gain and maintain a clear, complete, and constantly updated visual intelligence picture, meeting even the most basic littoral environment force protection requirements, does not exist.

Discussion: Our amphibious forces have been deploying for far too long without the necessary organic, dedicated visual surveillance support they deserve. Manned aircraft simply cannot compete with modern Unmanned Aerial Vehicle (UAV) technology in the vital area of long-dwell surveillance coverage. This fact was amply demonstrated by UAV performance in DESERT STORM and ALLIED FORCE. A rudimentary dedicated reconnaissance capability existed for ARGs deploying with RQ-2A PIONEER-equipped UAV detachments between 1992-98. In Spring of 1998, after continued mishaps and PIONEER losses, the Navy ceased UAV detachment support for normal ARG deployments. PIONEER support was then limited to contingency operations in order to preserve the remaining airframes. The Department of the Navy's answer to the pressing need for a PIONEER replacement is the Vertical Takeoff and Landing Tactical Unmanned Aerial Vehicle (VTUAV) program. Northrop Grumman's Ryan Aeronautical Center Model 379 FIRE SCOUT, developed from a manned helicopter airframe, was selected as the VTUAV program competition winner in February 2000. FIRE SCOUT UAVs are supposed to reach ARGs as a PIONEER replacement beginning in FY 2003.

Conclusion: The gaps in responsive coverage inherent even when dedicated manned surveillance aircraft support is available should be argument enough for aggressive acquisition of VTUAV capabilities for littoral operations. While the highly-adaptable FIRE SCOUT is definitely a much-needed step in the right direction, it should be considered only an interim solution. A viable VTUAV design offering much greater on-station flight endurance/dwell time is necessary for ARG situational awareness requirements.

Table of Contents

Page

DISCLAIMER..... i

EXECUTIVE SUMMARY.....ii

TABLE OF CONTENTS.....iii

SITUATIONAL AWARENESS IN LITTORAL OPERATIONS.....1

UNMANNED AERIAL VEHICLES.....7
- Unmanned Triumphs and Troubles.....10
- Gulf War Resurgence.....19
- Balkan Operations.....27

BASIC LITTORAL MISSION CAPABILITIES.....33
- Long-Dwell Flight Endurance.....33
- Remote Airborne Chemical Agent Detection.....35
- Remote Sniper Detection.....37

FIRE SCOUT VTUAV – A VITAL ORGANIC ARG/MEU ASSET.....38
- Conclusion.....40

BIBLIOGRAPHY.....41

SITUATIONAL AWARENESS IN LITTORAL OPERATIONS

The Navy/Marine Corps Team's Operational Maneuver from the Sea doctrine demands exceptionally high levels of situational awareness in order to achieve Full-Spectrum Dominance. A clear, complete, and constantly updated intelligence picture must be maintained on multiple key areas throughout all phases of amphibious operations. Amphibious Ready Group (ARG) and Marine Expeditionary Unit (MEU) elements must have uninterrupted access to assets providing an effective local intelligence picture – only with this access can ARG/MEU elements be assured the best possible chance for success in rapidly and decisively meeting the dynamic challenges to be found in difficult littoral environments. At present, the capability for regularly-deployed ARG/MEU elements to gain and maintain a clear, complete, and constantly updated visual intelligence picture, meeting even the most basic littoral environment force protection requirements, does not exist.

The purpose of this paper is to review the role of Unmanned Aerial Vehicles/Remotely Piloted Vehicles in achieving situational awareness in littoral operations, and the need for amphibious forces to gain and train with these capabilities. Central to the topic of capabilities will be

a historical examination of vehicle development and use in littoral operations by the United States' armed forces. Future vehicle capabilities, using current technology, that could prove exceptionally valuable in amphibious operations will also be discussed. The paper argues that these systems must be organic to the ARG, and extended flight endurance should be the primary design criteria to provide the level of long-dwell surveillance necessary to enhance ARG/MEU situational awareness in littoral operations.

Remarkable advancements in shipboard intelligence processing and dissemination capabilities have been made in recent years in response to essential ARG Intelligence Preparation of the Battlespace (IPB) requirements, mostly in the areas of improved organic access to national-level databases, imagery servers, and secure ship-to-ship/ship-to-shore computer network systems. Expeditionary Plot (EXPLOT) C4I installations were completed in Joint Intelligence Centers (JICs) on several LHD/LHA-Class Amphibious Assault ships specifically to address the pressing issue of enhancing situational awareness throughout all ARG/MEU units. While the EXPLOT concept has proven operationally to be highly successful, much room for improvement remains in the area of gaining and maintaining an accurate intelligence picture of the immediate littoral

operating area.

Foremost among critical ARG/MEU intelligence system requirements not effectively being met is the need for an organic, long-dwell tactical surveillance capability – an ARG/MEU system providing timely, sustained observation of developments within the immediate Amphibious Objective Area (AOA). Embarked U.S. Navy RQ-2A PIONEER Unmanned Aerial Vehicle (UAV) detachments gave a basic day/night video AOA observation capability to ARG deployments between 1992-98. In Spring 1998, after continued shipboard RQ-2A aviation mishaps and system losses, the Navy decided to cease PIONEER UAV detachment support to regularly-scheduled ARG/MEU deployments. The Navy's PIONEER program was then greatly reduced in mission scope, with deployments limited to contingency operations in order to preserve remaining airframes. This decision ensured that ARG/MEU deployments would go without PIONEER surveillance capabilities except in the most compelling military crises. Already-deployed amphibious groups would gain adhoc UAV support only if time and ARG location permitted deployment and embarkation of a PIONEER detachment prior to execution of contingency operations.

Reality dictates that, in most cases, deployed ARG/MEU

elements will immediately respond to contingencies with only what is already onboard, or what might possibly be flown aboard while enroute to the AOA. In light of this reality, an adhoc PIONEER detachment will very likely not be an option in potential ARG/MEU scenarios where it might be needed most. Today, without the live-video capabilities provided by an embarked PIONEER UAV detachment, organic ARG/MEU surveillance assets are disturbingly limited in meeting a fundamental situational awareness requirement for their role enabling Operational Maneuver from the Sea. In the past, day/night video surveillance support has proven extremely valuable during execution of ARG/MEU core competencies such as Non-combatant Evacuation Operations (NEO), Tactical Recovery of Aircraft and Personnel (TRAP), Maritime Interdiction Operations (MIO), and Visit-Board-Search and Seizure (VBSS) missions.

The Department of the Navy's answer to pressing ARG/MEU surveillance requirements is the Vertical Takeoff and Landing Tactical Unmanned Aerial Vehicle (VTUAV) program. The VTUAV, "a replacement for the Pioneer," has an ambitious "IOC scheduled for FY 2003:"[1]

> The Navy will operate the VTUAV from surface combatants in support of the naval operational concepts and the Naval Long-Term Planning Objectives.

[1] U.S. Navy, *Vision…Presence…Power - A Program Guide to the U.S. Navy 2000 Edition*, 76.

> The Marine Corps will operate VTUAV from the *San Antonio* (LPD-17)-class landing platform dock ship and amphibious assault ships (LHA/LHD) in support of Operational Maneuver from the Sea……. While the initial VTUAV system will be delivered with an electro-optical, infrared and laser (EO/IR/Laser) designator payload, there is ample growth capability to numerous other missions, including communications relay, electronic warfare, and mine countermeasures.[2]

Northrop Grumman's Ryan Aeronautical Center Model 379 FIRE SCOUT, "based on an upgraded version of the Schweizer Model 330SP manned helicopter," was selected in February 2000 by the Navy in the VTUAV competition, gaining "a $93.7 million contract for engineering, manufacturing and development."[3] Bell Textron's competing EAGLE EYE system was more complex, with a twin tilt-rotor design, and transitioned to wing-borne flight after vertical takeoff in the same manner as Bell Textron's much larger manned V-22 OSPREY. The tilt-rotor feature was an attempt to lower fuel consumption at cruising altitude, and extend loiter/surveillance time on station. Even with tilt-rotor technology, however, EAGLE EYE's endurance was little more than two hours total airborne.[4]

In VTUAV competition, FIRE SCOUT's proven helicopter

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[2] U.S. Navy, 76.

[3] "Northrop Grumman Awarded $93.7 Million Contract In U.S. Navy's Vertical Takeoff And Landing UAV Competition," Northrop Grumman news release, www.northgrum.com, accessed on *America Online*, 19 October 2000.

[4] Maj Stephen P. Howard, USAF, *Special Operations Forces and Unmanned Aerial Vehicles – Sooner or Later?* School of Advanced Airpower Studies, (Maxwell Air Force Base, AL: Air University, February 1996), 23.

airframe was surely seen as providing the least risk and long-term maintenance expense. FIRE SCOUT also represented a return to an earlier era in UAV development - the modifying of larger, heavier and less efficient manned aircraft designs for an unmanned mission.

The vertical takeoff and landing, helicopter-like VTUAV program airframe requirements were established to eliminate a root cause of numerous shipboard accidents experienced while launching and recovering the RQ-2A PIONEER. PIONEER is an airplane, necessitating hazardous booster-assisted takeoffs and tricky recovery procedures in which the RQ-2A is flown into a large, cumbersome net and framework apparatus which must be erected prior to UAV operations, then taken down afterwards. Even when successfully recovered in this way, PIONEER rarely emerges without some damage. During typically rough-and-tumble net recoveries, vital airframe antennas are often snagged and damaged or even broken off.

In addition to providing electro-optical and infrared surveillance capabilities superior to those of the PIONEER, the VTUAV is also to be equipped with a laser target designator – a significant capability which has great potential to radically change the way UAVs will be used in amphibious operations. It remains to be seen how the

addition of target designation capabilities will impact utilization of VTUAV in the long-dwell surveillance role. With high capacity for further growth of missions for the VTUAV, the very real possibility exists for the essential surveillance role to be sidelined in lieu of seemingly more pressing needs. More VTUAV airframes might need to be utilized to satisfy the increased level of requirements should the FIRE SCOUT program prove successful.

UNMANNED AERIAL VEHICLES

The Department of Defense has had an on-off, love-hate relationship with Unmanned Aerial Vehicle and Remotely Piloted Vehicle (RPV) programs in littoral operations. America's long history of unmanned, but controlled, military flight includes examples of both spectacular technological success and frustrating failure, sometimes in the same UAV/RPV program. U.S. Navy and Marine Corps' experience with UAV/RPV systems has differed little from that of the U.S. military as a whole. Despite the many difficulties encountered through the years in UAV design, development, testing, and operation, no other means of delivering responsive, long-dwell, real-time surveillance has proven more versatile and suitable to a wide range of

missions. This is especially true of UAV use aboard ship, where other terrain-based surveillance systems that ground forces take for granted are simply not an option.

UAV surveillance is much preferable to observation by manned aircraft for a number of reasons, but especially because of a clearly-demonstrated, superior efficiency in the all-important area of on-station dwell time. When relieved of innumerable requirements to provide redundant, human-factored control systems, instrumentation, life-support, safety equipment, and a large airframe with cockpit arrangements affording adequate visibility for a human aircrew, modern aircraft design can produce truly extraordinary results in time spent aloft. Even long-range manned aircraft have a limited time on station due to their engine fuel consumption and aircrew fatigue concerns when compared to the amazing endurance that can be demonstrated by modern UAVs:

> The technology to fly small autonomous unmanned aircraft is available now. For example, the 30-pound Aerosonde UAV flew 2,030 miles across the Atlantic Ocean in 26 hours on 1.5 gallons of gas. It had communications, navigation, and meteorological measuring equipment on board. Its total cost: $25,000.[5]

The fact that all manned aircraft assigned, or

[5] LCDR Pete McVety, USN, "An Unmanned Revolution," *Naval Institute Proceedings*, March 2000, 91.

available, to ARG/MEUs are designed and built to perform missions other than long-dwell surveillance means that they will rarely, if ever, actually be used for surveillance. Using manned aircraft in the observation role detracts greatly from ARG/MEU utilization of these vital assets in their own mission-critical areas.

Availability and assignment of appropriate non-organic manned surveillance assets, such as the Army's RC-7B Air Reconnaissance Low - Multifunction (ARL-M) aircraft, to support ARG/MEU littoral operations can not be counted on. The superb, near-real-time video surveillance the ARL provided in support of 1994 amphibious operations in Haiti will occur only in those rare circumstances where authorized, adequate, and secure land-based air facilities are close enough to allow sufficiently useful on-station dwell time after transit.[6]

Last, but certainly not least, organic UAV systems are specifically designed to provide video imagery or other reconnaissance information of value – in the vast majority of scenarios, they can simply do the job better and more efficiently than manned aircraft:

> What the future holds is open to debate but there no longer is any doubt that UAVs have rapidly gained the

[6] David A. Fulghum, "Army Spy Aircraft Watch North Korea", *Aviation Week & Space Technology*, 24 November 1997, 2.

> attention of military commanders for good reasons. They are relatively inexpensive and can effectively accomplish vital missions without risking human life. We already have sufficient experience with UAVs to know that they will revolutionize warfare.[7]

Unmanned Triumphs and Troubles

A review of U.S. UAV/RPV programs is deeply troubling. What is disconcerting is that, instead of a record of varied and failed developmental prototypes, there is a rich history of amazing successes and achievements in unmanned flight which have been overshadowed by budgetary cutbacks, changes in procurement priorities, service political agendas and/or the need at any given time to maintain program secrecy. America's history of UAV/RPV development has been one of profound failure to follow through in exploiting technological advancements sooner rather than later – a legacy which has negatively impacted the current status of UAV development in the United States.

As is so often the case in military technological advances, wartime urgency provided the early impetus for unmanned aircraft development and subsequent innovations. Truly stable and controllable unmanned flight was first made possible with successful introduction in 1913 of the "gyro stabilizer" by Lawrence Sperry on Long Island.[8]

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[7] Hugh McDaid and David Oliver, *Smart Weapons* (New York: Welcome Rain, 1997), 6.
[8] Kenneth Munson, *World Unmanned Aircraft* (London: Jane's Publishing Company Limited, 1988), 7.

Early U.S. Navy experiments were conducted with Curtiss N-9 trainers "capable of flying 50 miles carrying a 300 lb load" after conversion into "radio-controlled 'aerial torpedoes' at Long Island in December 1917."[9] The first U.S. unmanned aircraft were designed as World War I-era offensive weapons systems, representing, in effect, the cruise missile technology of their day:

> A more sophisticated unmanned aircraft was designed by Charles F. Kettering of Delco, later General Motors. Powered by a 40 hp Ford engine, the 12 ft wing-span biplane could carry a bomb load equal to its own weight – 300 lb. Built primarily of wood and canvas, the 'Kettering Bug' cost some $400 each and was the first UAV to be mass produced.[10]

The Army's 1918 "Kettering Bug" flew autonomously to its target up to 40 miles away "by preset controls" which also commanded when "the wings would be released, and the fuselage would plunge earthward as a bomb."[11] With the Armistice, and only "eight successful test flights out of 36," interest in the "Kettering Bug" waned.[12]

In over-all concept, and much of their technology, "Kettering Bugs" differed little from German V-1 "Buzz Bombs" introduced 25 years later and hailed as a highly

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[9] McDaid and Oliver, 10.
[10] Ibid.
[11] William Wagner, *Lightning Bugs and other Reconnaissance Drones* (Fallbrook, CA: Armed Forces Journal International in cooperation with Aero Publishers, Inc., 1982), 86.
[12] LtCol Richard M. Clark, USAF, *Uninhabited Combat Aerial Vehicles – Cadre Paper No. 8*, College of Aerospace Doctrine, Research and Education (Maxwell Air Force Base, AL: Air University, August 2000), 8.

advanced, completely new and revolutionary concept in modern warfare. One can only wonder what level of sophistication a continued American "aerial torpedo" or "Kettering Bug"-type program might have achieved by the outbreak of World War II. With a concerted follow-through in unmanned combat and reconnaissance aircraft research, development, and testing during the inter-war years, U.S. and Allied military operations against Germany and Japan might very well have proven radically different. In fact, perhaps the most noteworthy American achievement in unmanned military flight between the wars was an Army program that fell victim to depression-era funding cuts:

> Recommendations springing from the Kettering plane led to the first successful droning of a commercial Curtiss Robin monoplane in 1928. This radio-controlled, bomb-carrying airplane floundered through the skies on and off for four years before expiring from lack of funds in 1932.[13]

A considerable number of airmen might have been saved by use of unmanned combat aircraft. Even a few additional lives saved would have been worth the effort in light of heavy combat aircraft and aircrew losses suffered by the Allies while conducting deep strike and air interdiction campaigns during World War II. The extremely manpower-intensive nature of combat aviation itself would

[13] Wagner, 86.

have been drastically altered had unmanned aircraft technology been allowed to mature from its World War I origins.

Predictably, U.S. military interest in unmanned flight resumed only in the late thirties with gathering evidence of war looming in Europe. With the U.S. entry into World War II, remote-controlled aircraft were once again seen as primarily useful in an offensive strike or interdiction role - now against higher value, heavily defended point targets and ships. In England, the U.S. Army Air Force and Navy "project ANVIL" and the USAAF "project APHRODITE" used obsolescent or worn-out heavy bomber aircraft converted for remote-control and guided by accompanying manned aircraft – after a takeoff and safe flight to British coastal areas had been accomplished by an aircrew who would then bail out.[14] Manned control aircraft maintained a respectful distance from these explosives-laden "drones" while enroute, and guided them into the target while, conceptually at least, remaining outside enemy anti-aircraft artillery range:

> The U.S. Navy's SAU-1 (Special Air Unit One) used PB4Y-1 Liberators equipped with remote control, a TV-guidance system, and loaded with 25,000 lb of torpex high explosive. Guided by a PV-1 Ventura 'mother'

[14] McDaid and Oliver, 21.

> aircraft, the PB4Y-1 would take off with a two-man crew who would climb to 2,000 ft and set a course for V-1 sites in France before bailing out. However, the first Anvil operation by SAU-1, on 12 August 1944, was a tragic failure……PB4Y-1 Bureau Number 32271 exploded soon after take-off and before the crew's planned bail-out over the English Channel. Despite this failure, a PB4Y-1 drone was used successfully against submarine pens on Heligoland Island.[15]

Unique amongst American unmanned aerial vehicle programs during World War II, the Naval Aircraft Factory TDN-1 was a purpose-built, twin-engine, remotely-controlled attack aircraft that demonstrated great promise in carrying "a torpedo or a 2,000 lb bomb at a cruising speed of 175 mph":[16]

> Its successor, the TDR-1, carried out the first live operations in July 1944, when four drones of STAG-1 (Special Task Air Group One), loaded with 2,000 lb bombs, took off from the northern Solomon Islands against a Japanese merchantman, the *Yamazuki Maru*, and scored two direct hits. STAG-1 launched a total of 46 TDR-1s from Banika Island, near Guadalcanal, between September and October 1944, achieving a 50 per cent hit rate.[17]

STAG-1 combat results compared favorably with contemporary manned combat aircraft unit performance, even without consideration of the major benefit of no lives lost. The tremendous advantages that advanced, unmanned military aircraft programs could bring to modern combat operations should have been abundantly clear to senior civilian and

[15] McDaid and Oliver, 21.
[16] McDaid and Oliver, 13.
[17] Ibid.

military leadership by 1944. With World War II soon ending, however, peacetime funding priorities limited further advancements in Unmanned Military Aircraft (UMA) technology.

Post-World War II interest in unmanned flight centered mainly on development of more advanced cruise missiles through study of captured German V-1 weapons, design of high-performance RPVs specifically as target drones, and conversion of old fighters to remote controlled targets and air samplers for nuclear weapons tests. It took the advent of the Cold War and Russian advancements in Surface-to-Air Missile technology, however for the Department of Defense (DOD) to recognize requirements for efficient and effective unmanned reconnaissance aircraft. The modification of high-performance target drones to reconnaissance platforms proved most effective in meeting this challenging requirement.

Ryan Aeronautical's highly successful 50's-era FIREBEE target drone airframe, originating from a 1948 jet-powered target drone specification, was the basis for the "Red Wagon" unmanned reconnaissance program and an entire family of Ryan intelligence-gathering RPVs that proved themselves operationally throughout the Vietnam era:[18]

[18] Wagner, 87.

> In the next eight years……over 3,000 unmanned RPV missions were flown over North Vietnam, China, Laos and elsewhere. With each such mission, new needs and new uses evolved for the program, first renamed "Lightning Bug" and later "Buffalo Hunter." The 1960 Ryan Firebee target drone grew into over 20 RPV configurations…….with an increasing variety of payloads for photographic and then electronic intelligence and covert psychological warfare missions……. RPVs returned precision intelligence deep from hostile territory without risking the men "flying" the recce drones to possible death or capture. They flew their missions at a fraction of the cost of manned reconnaissance aircraft, whether measured in dollars, lives, or political risk (as in the flights over mainland China).[19]

The marked success of Ryan's series of intelligence-gathering RPVs during the Vietnam era was eclipsed by the obvious necessity for maintaining security surrounding these sensitive operations; this helped to ensure continued outstanding results:

> …between 1964 and 1975, a total of 3,435 operational drone sorties was flown by USAF's 100th Strategic Reconnaissance Wing, and from 2,873 of those sorties – nearly 84 per cent – the drone came back. From 1972, as more sophisticated models were introduced, survival rates were well in excess of 90 per cent.[20]

In addition to success in adapting to expanding reconnaissance missions, the versatile FIREBEE airframe again served as a basis for the next logical step in unmanned aircraft development - experimental armed variants capable of flying into high-threat combat environments and

[19] Wagner, (Forward).
[20] Munson, 7.

delivering "Maverick, Stubby Hobo missiles, and Mark 81 and 82 iron bombs."[21] Incredibly, the promise of these armed prototypes was cut short by the end of the Vietnam War and subsequent program cutbacks. ALL DOD Unmanned Military Aircraft (UMA) programs were cancelled/ discontinued in a budget era in which available funding was used to keep manned aircraft programs flying:

> Proponents of UMAs were confident that RPVs had proved their case, and were set to become a major new 'force multiplier' in military thinking. Instead, the expected upturn in their fortunes failed to materialize, and five years after Viet Nam the USA had not one single operational RPV in its inventory.[22]

With such remarkable advances in UMA/RPV technology during the Vietnam era, it should not be surprising that the U.S. Navy's current FIRE SCOUT VTUAV program cannot be described as an entirely new concept. In fact, the Navy developed an advanced, remotely controlled, unmanned helicopter specifically for shipboard use more than 35 years ago:

> One of the most ambitious post-war US Navy drone programs was the Drone Anti-Submarine Helicopter (DASH). This called for the development of a remotely piloted, rotary-wing aircraft for deployment on all of the US Navy's destroyer fleet by 1963 – the QH-50C was designed to be launched from a destroyer's aft flight deck as soon as contact was made with a target submarine by the ship's sonar. The drone was

[21] McDaid and Oliver, 41.
[22] Munson, 7.

> controlled from the ship's Combat Information Center (CIC). When the sonar and the DASH's positions coincided, the controller actuated arming and release switches to drop a torpedo or nuclear weapon. The QH-50C was then flown back to the ship and retrieved by an automatic cable-landing system that permitted the drone to operate in any sea condition suitable for anti-submarine operations.[23]

Full utilization of this amazing anti-submarine system by the Navy was prevented by severe difficulties with "persistent vibration problems, which caused 26 of the first 100 drones to crash, (and) led to the order for 900 QH-50Cs being reduced to 534 by 1966."[24] Despite serious developmental problems encountered in the program, the tremendous potential for DASH RPVs to be used in the ship-based surveillance role did not go unnoticed:

> In addition to ASW mission, QH-50Cs and Ds equipped with TV systems were used by USN for surveillance and target spotting under **Project Snoopy**. Operating from a destroyer off the coast of Viet-Nam, the drone's TV camera relayed real-time data to the shipboard monitor to provide guidance for firing of ship's guns at detected land targets.[25]

Experimental programs with even more sophisticated surveillance, targeting, and offensive capabilities were conducted with the highly versatile QH-50D RPVs by the Defense Advanced Research Projects Agency (DARPA):[26]

> Others used in DARPA programmes **Nite Panther** and **Nite Gazelle**, initiated in January 1968. Former provided

[23] McDaid and Oliver, 25-6.
[24] McDaid and Oliver, 26.
[25] Munson, 157.
[26] Ibid.

> for installation and flight test of Cohu day/night TV cameras, motion and still cameras, Korad laser rangefinder/target designator, moving target indicator radar, covert illuminator, and other sensing and detection equipment. Nite Gazelle programme similarly tested weapon installations, including Minigun, high-velocity gun, grenade launcher, bomblet dispensers, bombs, and Martin Marietta LARS (laser-aided rocket system) missiles.[27]

It is a depressing fact that the levels of sophistication in littoral surveillance, target designation, and offensive capabilities that had been achieved by Project Snoopy and the Nite Panther/Nite Gazelle programs more than thirty years ago are not available today in a reliable tactical UAV organic to deploying U.S. amphibious forces.

Gulf War Resurgence

U.S. Naval Forces in OPERATIONS DESERT SHIELD and DESERT STORM would have been without vital day/night video reconnaissance support if not for the purchase of Israeli-designed PIONEER tactical UAVs in the years immediately preceeding the Gulf War. Representing a decidedly more pragmatic and lower-tech approach to unmanned aircraft design, the Israelis established an enviable record of success with their indigenous UAV programs during the 1980's. Israeli systems owed much of their technology to

[27] Munson, 157.

earlier abandoned U.S. developmental efforts. Effective Israeli employment of UAVs in military surveillance operations over Lebanon was particularly noteworthy:

> Searcher UAVs carried out a 24-hour watch out during the 16-day artillery war between Israeli and Hizbollah gunners across the security zone of southern Lebanon. Some of the UAVs were controlled from IAI Arava early-warning 'mother' aircraft. The dramatic visual images relayed by the Israeli UAVs during Operation Grapes of Wrath became a familiar sight to TV viewers around the world. Israeli UAVs had flown more than 1,200 hours in bad weather with no losses and largely dictated the nature of the battle.[28]

Watching these operations with keen interest, "the Navy initiated an expedited procurement of UAV systems."[29] The U.S. Navy's concept was to buy a combat-proven, simply-built, Israeli day/night video reconnaissance UAV system instead of a complex, expensive, and less-than-successful, indigenous U.S. design, such as the Lockheed AQUILA. The AQUILA program was an ill-fated "battlefield RPV for the U.S. Army" characterized by long delays and massive cost overruns:[30]

> The resulting Pioneer, produced by a joint venture of an American and Israeli firms, skipped the traditional U.S. development phase of the acquisition process, and nine systems, each with eight air vehicles, were

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[28] McDaid and Oliver, 52-3.

[29] General Accounting Office, *Unmanned Aerial Vehicles – DOD's Acquisition Efforts: Statement of Louis J. Rodriguez, Director, Defense Acquisitions Issues, National Security and International Affairs Division*, Testimony Before the Subcommittees on Military Research and Development and Military Procurement, Committee on National Security, House of Representatives, 9 April 1997 (Washington, D.C: GAO, 1997), 2.

[30] Munson, 9.

procured beginning in 1986 at an estimated cost of $87.7 million.[31]

Department of the Navy requirements for PIONEER were two-fold; the first was for a video-equipped, sea-based, Naval Gunfire Support (NGFS) targeting UAV for embarkation on recently-recommissioned IOWA-Class battleships. In this capacity, PIONEERs would handle spotting missions previously flown from the World War II-era battleships by catapult-launched, manned floatplanes. The second requirement was for a sorely-needed, ground-based, battlefield surveillance UAV for the Marine Corps (USMC). The importance of PIONEER to Marine operations would further increase with deactivation of VMFP-3 and retirement of all Marine RF-4B PHANTOM reconnaissance jet aircraft in Spring of 1990.[32] The USMC then went without a manned reconnaissance jet aircraft until Advanced Tactical Air Reconnaissance System (ATARS)-modified F/A-18Ds reached initial operational capability with VMFA(AW) squadrons deployed in 1999 during the ALLIED FORCE Kosovo Air Campaign.[33]

Like the DASH program, however, successful integration of UAVs into regular U.S. Navy operations once again proved frustratingly difficult and alarmingly destructive:

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[31] GAO, 2.
[32] Clark, 35.
[33] Greg L. Davis, "TAC RECCE returns to USMC," *Air Forces Monthly*, December 2000, 48-50.

> The Pioneer began to encounter unanticipated problems almost immediately. Recovery aboard ship and electromagnetic interference from other ship systems were serious problems that led to a significant number of crashes. The Pioneer system also suffered from numerous other shortcomings. Ultimately, the Navy undertook a $50 million research and development effort to bring the nine Pioneer systems up to a level it described as a "minimum essential capability"[34]

Even with only a "minimum essential capability," Navy and Marine PIONEERs performed their tasks brilliantly during the Gulf War, providing responsive, timely video imagery that would prove essential to commanders and save Americans in the field. PIONEERs also demonstrated, in a profound manner, how UAVs can contribute to Full-Spectrum Dominance during high-tempo combat operations in a littoral environment:

> UAVs were used to map Iraqi minefields and bunkers, thus allowing the Marines to slip through and around these defenses in darkness, capture key command sites without warning, and speed the advance into Kuwait City by as much as two days…….a live Pioneer UAV picture showed a battalion of Iraqi tanks poised on the north end of the airfield for a counterattack. The armored force was broken up by naval gunfire and air attacks before it could strike the advancing Marines.[35]

Clearly, the success of UAVs in helping to establish and maintain a superior day/night battlespace picture was a major lesson learned from Operation DESERT SHIELD and

[34] GAO, 2.
[35] Clark, 35.

DESERT STORM. Lieutenant General Walter Boomer, Commander of the 1st Marine Expeditionary Force (I MEF), referred to the PIONEER UAV as "the single most important intelligence collector" comprehensively supporting the highly-dynamic MEF advance into Kuwait towards Kuwait City:[36]

> They were flown by the Navy from battleships and by the U.S. Marine Corps from shore launchers in the Gulf War. Some 40 PIONEERs flew 552 sorties, yielding a total mission duration time of 1,641 hours. At least one Pioneer was airborne at all times during the Operation Desert Storm fighting in Jan.-Feb. 1991. The drones were employed to adjust naval gunfire, assess battle damage, and conduct reconnaissance. On Feb. 27, 1991, when a Pioneer detected two Iraqi patrol boats off Faylaka Island, naval aircraft were called in to destroy the craft. Seeing the drone and thinking they were about to be attacked, Iraqi soldiers on the island surrendered to the Pioneer! It was the first recorded surrender of enemy troops to an unmanned vehicle.[37]

PIONEER missions were not flown without difficulty during the Gulf War; a total of 12 PIONEERs were lost.[38] Of PIONEER losses, only "one PIONEER was shot down by the Iraqis."[39] Much smaller, quieter, and emitting a far weaker infra-red signature than manned aircraft, the relatively low-flying and slow PIONEER UAVs still proved a difficult

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[36] McDaid and Oliver, 60.
[37] Norman Polmar and Thomas B. Allen, *Spy Book – The Encyclopedia Of Espionage* (New York: Random House, 1998), 466.
[38] McDaid and Oliver, 60.
[39] LT Vernon L. Junker, USN, *Tactical Unmanned Aerial Vehicles In A Proposed Joint Infrastructure To Counter Theater Ballistic Missiles*, MSOR Thesis (Monterey, CA: Naval Postgraduate School, March 1995), 18.

target for Iraqi ground fire. This survivability is especially noteworthy considering that intense smoke from numerous oil field fires forced PIONEERs to fly even lower than their normal flight regime. Virtually incapable of performing effective evasive maneuvers to counter enemy anti-air threats, the PIONEER's best defense was avoidance of identified high-intensity threat areas altogether – unless overflight was necessary to gain required imagery information. In such cases, flying PIONEER over the threat area was still far preferable to endangering a manned aircraft.

Conducting high-tempo combat reconnaissance operations in support of U.S. forces during DESERT STORM with unmanned aerial vehicles (UMAs) proved challenging, as evidenced by the loss of eleven PIONEERs to accidents. Particularly in the maritime environment, chronic difficulties in performing damage-free shipboard recoveries continued; "it is one thing to land a UMA on a flat strip of sunlit desert, but quite another to try catching it in a net mounted on the heaving deck of a ship at sea."[40] In spite of these accidental losses, shipboard PIONEER operations were largely seen as an operational success during the Gulf War.

[40] Munson, 9.

The case for the Navy's retaining organic shipboard UAV capabilities had been persuasively made in the Gulf. After decommissioning all IOWA-Class battleships and de-emphasizing the naval gunfire support mission for which PIONEER systems had originally been acquired, the Navy decided to retain PIONEER for its demonstrated value in maintaining situational awareness during littoral operations. Until cessation in mid-1998, subsequent Navy RQ-2 deployments would support Amphibious Ready Groups, with PIONEER detachments embarked on modified AUSTIN-Class Landing Platform Dock (LPD) ships.

This less-than-optimal arrangement required launch and recovery equipment to be set up on the LPD's flight deck – effectively closing down a substantial helicopter platform to all other aviation operations while supporting PIONEER flights. Although helicopters are not normally embarked on AUSTIN-Class LPDs, the ability to rapidly airlift equipment, cargo and troops via helicopter from an LPD's flight deck is a major portion of the LPD mission in support of amphibious operations. Many naval amphibious warfare professionals saw embarked UAV detachment surveillance capabilities as a painful and troublesome, if nice-to-have, feature. This was seen as especially true if

PIONEER video effectively came at the cost of interfering with mission accomplishment of a major Amphibious Ready Group asset – their one and only LPD. Not all AUSTIN-Class ships were modified to accommodate PIONEER launch and recovery gear; therefore, several ARGs deployed prior to the 1998 cessation of detachment embarkations without PIONEER video reconnaissance assets.

Navy difficulties encountered from the beginning with PIONEER indicated clearly the need for a new UAV system eliminating the launch and recovery problems inherent with the RQ-2A design. Bell Textron's answer to shipboard UAV launch and recovery challenges was the EAGLE EYE tilt-rotor UAV prototype that first flew more than seven years ago in 1993.[41] The genesis for EAGLE EYE was a common sense approach reminiscent of the Navy's earlier DASH program, that "some form of rotorcraft or other VTOL air vehicle would seem to offer a better solution to most naval requirements."[42] EAGLE EYE would later vie with the FIRE SCOUT for selection in the U.S. Navy's VTUAV program competition.

[41] Polmar and Allen, 467.
[42] Munson, 9.

Balkan Operations

It would be reasonable to expect increased Department of Defense interest in, and funding for, UAV programs after their Gulf War success, to result in development, testing, and fielding of several new, unmanned surveillance systems with superior collection capabilities. In fact, only one program has been truly successful in introducing a new unmanned reconnaissance system to the inventory since PIONEER – General Atomics' PREDATOR Medium Altitude Endurance (MAE) UAV for the U.S. Air Force, which entered operational squadron service in September of 1996.[43] The situation was made depressingly clear in an April 1997 GAO report to Congress:

> According to DOD, its objective in acquiring UAVS is to provide unmanned systems that will complement its mix of manned and national reconnaissance assets. However, its UAV acquisition efforts to date have been disappointing. Since Aquila began in 1979, of eight UAV programs, three have been terminated (Aquila, Hunter, Medium Range), three remain in development (Outrider, Global Hawk, DarkStar), and one is now transitioning to low rate production (Predator). Only one of the eight, Pioneer, has been fielded as an operational system. We estimate DOD has spent more than $2 billion for development and/or procurement on these eight UAV programs over the past 18 years.[44]

The state of post-Gulf War DOD development of UAVs was even more gloomy in light of the fact that, by 1999, the

[43] McDaid and Oliver, 113.
[44] GAO, 1.

OUTRIDER and DARKSTAR programs had also been cancelled. General Atomics' successful PREDATOR design was essentially only an up-sized adaptation of their pre-existing GNAT 750 UAV, which had been in service with the Central Intelligence Agency (CIA) since at least January of 1984:[45]

> In a very short period of time, General Atomics Aeronautical…developed the Gnat 750 from a project originally named Amber 1. What the CIA got was a tactical-reconnaissance/surveillance UAV optimized to their requirements, which were: an endurance of 24 to 30 hours at 5,000 to 15,000 ft with a relatively small 140 lb, state-of-the-art electro-optical (EO) payload.[46]

CIA acquisition of GNAT-750 differed greatly in comparison with Department of Defense experiences in UAV development, where "Pentagon staffs are finding that UAVs are costing more than they expected by a factor of four."[47] Part of the CIA's success with UAVs can be attributed to its approach - it needed only a limited number of airframes to meet specific collection requirements. The DOD acquisition approach has been much like that for manned aircraft developmental programs:

> 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

[45] Tom Kaminski and Mel Williams, *The United States Military Aircraft Directory* (Norwalk, CT: AIRtime Publishing, 2000), 57.
[46] McDaid and Oliver, 102-04.
[47] Wng Cdr Andrew Brookes, "UAVs – a hip culture," *Air Forces Monthly*, December 2000, 47.

> provides near-real-time information to the field commander at what appears to be a very low cost.[48]

As early as 1993, the CIA was successfully conducting GNAT 750 operations over Bosnia from the "Croatian island of Hvar."[49] The GNAT 750 represented practical, long-dwell surveillance capabilities that had not previously been available in unmanned aircraft. Enhanced endurance equated to possibilities for much longer range GNAT 750 missions, penetrating far deeper into hostile territory when using "intermediate data-relay aircraft" or improvements in installed communications equipment, such as "a dome to the back of the aircraft which contained a satellite aerial."[50]

General Atomics' RQ-1A PREDATOR is larger than the GNAT 750, with "an endurance of up to 40 hours and a cruising altitude of 25,000 ft with a 450 lb payload, including a hi-tech synthetic aperture radar (SAR)."[51] With greater long-dwell surveillance endurance than the GNAT 750, PREDATOR provides its operators with an unmatched aerial capability to detect activity within Named Areas of Interest (NAI). The PREDATOR UAV's superior stay time proved the effectiveness of long-dwell surveillance during operational testing and evaluation over Bosnia:

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[48] Howard, 19.
[49] Clark, 36.
[50] McDaid and Oliver, 103.
[51] McDaid and Oliver, 107.

> With Predator, however, weapons movements became subject to long-dwell video surveillance, and continuous coverage of roads showed no evidence of weaponry being withdrawn. This UAV resource thus gave NATO commanders the key piece of intelligence that underlay their decision to resume the bombing campaign which, in turn, led to the Dayton peace accord signed in December 1995.[52]

In addition to on-station dwell time superiority, the slower ground speed of PREDATOR offers greater chances of observing targeted area activity in comparison to faster, manned aircraft. In the long-dwell surveillance mission, faster is not better:

> UAVs are less vulnerable to enemy air defenses and may search from altitudes and velocities that maximize the probability of detecting the target. The ability to fly lower and slower over hostile territory gives UAVs a distinct advantage in probability of detection over manned aircraft.[53]

The performance of PIONEER and HUNTER reconnaissance systems in operations over Serbia and Kosovo in 1999 was clearly proof of the high value of long-dwell surveillance capabilities in combat; "NATO's Operation ALLIED FORCE in Yugoslavia demonstrated that a new age in reconnaissance is in fact dawning."[54]

> UAVs were another ALLIED FORCE success story, with the US and European UAVs conducting important reconnaissance operations and battle damage assessments, and the Predator becoming the first US

[52] McDaid and Oliver, 107.
[53] Junker, 47.
[54] Tom Ripley, "UAVs Over Kosovo," *Air Forces Monthly*, September 2000, 57.

> UAV to designate a target for an A-10-launched laser-guided bomb.[55]

Despite glowing reports on the effectiveness of our long-dwell UAV surveillance capabilities operating deep within the former Yugoslavia during ALLIED FORCE, a disturbing trend was noted during the sustained conduct of UAV combat reconnaissance operations. The Serbs were developing tactics, techniques and procedures to deal with UAVs:

> The most innovative Serb anti-UAV tactic was the use of helicopters. It appears that the first Hunter lost during the campaign was shot down after the Serbs launched a Mil Mi-8 ***Hip*** helicopter to fly alongside the UAV and then a door-gunner blasted the air vehicle with a 7.62mm machine-gun. This became a favorite tactic until Allied fighters made it rather dangerous. The vulnerability of UAVs to hostile fire quickly made operators want to move almost exclusively to night flying to reduce attrition rates on the small number of airframes available.[56]

Three PREDATORs were lost during ALLIED FORCE - two were combat losses and one was accidental; HUNTER losses totaled eight, with five shot down and three destroyed in accidents.[57] The Army's cancelled-but-resurrected HUNTER UAV program did not fare well during ALLIED FORCE. Originally deploying from the United States with eight UAVs, TASK FORCE HUNTER would eventually receive six replacements after effectively losing its original eight

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[55] Wng Cdr Andrew Brookes, "European Lessons," *Air Forces Monthly*, June 2000, 27.
[56] Ripley, 59.
[57] Ibid.

airframes.[58]

ALLIED FORCE use of Navy PIONEERs consisted of one contingency VC-6 detachment on the USS PONCE. Though RQ-2A use was limited to surveillance of coastal areas, two PIONEERS were shot down.[59] It would appear that current technology, long-dwell UAV operations deep into hostile territory are increasingly becoming vulnerable to enemy countermeasures. The degree of vulnerability, however, will always be a direct function of hostile nation military expertise, technical capabilities, and resolve. Despite USS PONCE/VC-6 combat losses during ALLIED FORCE, using long-dwell UAVs in littoral environments may provide better potential for mission survivability. The destruction of UAVs by hostile ground forces is obviously made more difficult in coastal areas if the UAV is able to maintain surveillance capabilities at, or near, stand-off distances over water. In any case, the loss of a UAV will always be more acceptable than the loss of a manned aircraft and crew or the completely unacceptable failure to gain vital situational awareness in a timely manner.

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[58] Tom Ripley, "Kosovo Focus – Task Force Hunter," *Shephard's Unmanned Vehicles*, October 1999, 30.
[59] Robert Hewson, "Allied Force Part 2: Overwhelming Airpower," *World Airpower Journal*, Winter 1999, 125.

BASIC LITTORAL MISSION CAPABILITIES

Combat experience in the Gulf and Balkans has shown that UAVs can be a vital source of situational awareness in littoral environments. The U.S. Navy has officially identified three possible, future capabilities for the FIRE SCOUT VTUAV beyond the basic electro-optical, infrared and laser designator payload. However, before “communications relay, electronic warfare, and mine countermeasures” capabilities are added, three more important, and possibly easier, enhancements should be considered for FIRE SCOUT. Foremost among improvements should be an effort to extend the FIRE SCOUT’s airborne on-station dwell time. The current proliferation of chemical weapons necessitates a requirement for the VTUAV to be able to remotely sense chemical agents. Finally, the possibility of incorporating a light-weight, remote sniper-detecting system on the FIRE SCOUT is a prospect demanding immediate attention.

Long-Dwell Flight Endurance

The demonstrated superior efficiency in observation capabilities of long-dwell UAVs and their comparative expendability over manned aircraft are good arguments for their use in both peacetime downed aircraft search and Combat Search And Rescue (CSAR) missions:

> UAVs should fly many of such combat search and rescue missions in the future to avoid putting other aircrew at risk. UAVs can now loiter over a combat area for very long periods.[60]

As in CSAR missions support, the advantages of long-dwell surveillance capabilities while conducting Tactical Recovery of Aircraft/Personnel (TRAP) operations could prove the deciding factor in success or failure in this basic ARG/MEU mission area. The ability to reactively loiter over more than one location during any one flight to satisfy dynamic reconnaissance requirements associated with **ALL** basic ARG/MEU missions and Operational Maneuver From the Sea is obviously enhanced with extended flight endurance.

Long-dwell airborne surveillance capabilities are essential in establishing support for pro-active tactics, techniques, and procedures effectively meeting challenges for comprehensive force protection of ARG/MEU units. The October 2000 assault on the USS COLE demonstrated the long-dreaded "danger to ships from terrorist type threats e.g., use of civilian aircraft or boats for kamikaze/martyr type missions."[61] Constant situational awareness is the key to detecting potential threats to ARG/MEU assets:

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[60] Brookes, (Dec 2000), 46.
[61] LtCol Daniel T. Morris, USA, *Unmanned Aerial Vehicles: Options For The Operational Commander*, (Newport, RI: Naval War College, May 1992), 14.

> One of the most serious threats to the operational commander exists from the small boat attack on naval shipping. Consequently the Anti Surface Warfare (ASUW) mission is extremely important……. UAVs with imaging capability and data link relays could be strategically positioned and maintained on a continuous basis to monitor a specific area…… This mission although difficult during the day becomes extremely complex at night and provides a distinct advantage to the attacker. A FLIR configured UAV continuously on station could provide mission support in this most threatening situation.[62]

At present, the FIRE SCOUT VTUAV is advertised to have little more than a six-hour operational flight endurance. Any additional flight duration that might be obtainable through fuel-capacity-for-weight tradeoffs meeting "high and hot" flight performance parameters should be thoroughly investigated. The ability of the FIRE SCOUT VTUAV system to effectively provide seamless ARG/MEU situational awareness in littoral environments will be a direct function of individual airframe flight longevity when on station.

Remote Airborne Chemical Agent Detection

The feasibility of achieving effective and timely remote detection of chemical warfare agents using UAVs was successfully demonstrated by the U.S. Central Measurements and Signatures Intelligence (MASINT) Testing Office in

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[62] CDR Kevin F. Lover, USN, *Unmanned Aerial Vehicles – An Asset For The Operational Commander*, (Newport, RI: Naval War College, May 1990), 21.

1995. Their Holistic UAV Surface Acoustic Wave Chemical Agent Detector (SAWCAD) Sensor Integration Experiment – "HUSSIE", for short, involved the installation of a SAWCAD within the reconnaissance equipment bay of an RQ-2A PIONEER fuselage. The largest component of the system was the agent detector's battery. The PIONEER was flown through several chemical agent simulant clouds and broken-down, parts-per-million concentration results were relayed in near-real-time back to the operator's station over the normal data link. HUSSIE proved in each case remarkably successful in accurately determining the contents of chemical "cocktails" – simulated lethal clouds composed of mixtures including two or more chemical agents.

The ability to remotely detect lethal chemical agents with UAVs will likely prove vital in future amphibious operations as a basic force protection requirement. The use of chemical agents against an amphibious force still at sea, or at least over the horizon, would no doubt be a tempting option for adversaries seeking to thwart Operational Manuever From the Sea.

The installation of diminutive SAWCAD components would provide ARG/MEU units with optimal indications and warning of the presence of lethal chemical agents, well before shipboard Chemical Agent Point Detection Systems (CAPDS)

could give the alarm. The need for ARG/MEU units to have this remote-sensing capability is obvious.

Remote Sniper Detection

Very encouraging progress has been made by Lawrence Livermore National Laboratories in the field of ballistic detection, with specific relevance to military and law enforcement applications. Particularly noteworthy is the fact that their bullet flight detection system is small enough that "applications include attaching the device on police helicopters."[63] The police helicopter-sized airframe of the FIRE SCOUT VTUAV should easily accommodate addition of this incredible capability:

> The Lawrence Livermore National Laboratories of Livermore, CA, has developed a portable anti-sniper detection device called the Lifeguard System. It is said to have the capability of tracking bullets in flight and displaying the flight track to an operator, who can then pinpoint the source of fire within hundredths of a second.[64]

The application of this existing technology in UAV surveillance support to amphibious operations could prove indispensable, providing ARG/MEU elements effective targeting data to counter incoming fire during the highly vulnerable ship-to-shore entry phase and subsequent

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[63] Robert Hausman, "New, Non-Lethal Technologies Offer More Options to Police," URL: http://www.saf.org/pub/rkba/general/haus220.html accessed 8 January 2001.
[64] Houseman, 3.

maneuver operations inland. Lifeguard-equipped UAVs would be especially useful during the conduct of combat operations in highly hazardous built-up coastal areas and potential “three block war” scenarios:

> Lifeguard’s key components include a sensor that identifies a moving bullet through its unique signals and a computer that processes the signals into an image. During a recent demonstration, the equivalent of an M-16 rifle was fired at a target. The sensor spotted the bullets, while Lifeguard’s video screen recreated each bullet’s flight path back to its source. A small red rectangle on the computer screen outlined the area where the “sniper” stood.[65]

The incorporation of Lifeguard, or Lifeguard-like capabilities, into the FIRE SCOUT VTUAV program should be expedited as a primary example of this system’s “ample growth capability to numerous other missions” in support of essential ARG/MEU force protection and situational awareness requirements.

FIRE SCOUT VTUAV – A VITAL ORGANIC ARG/MEU ASSET

The pressing need for ARGs with embarked MEUs to deploy with their own UAV surveillance capabilities has been historically documented in both high-tempo combat support and Peacetime Contingency Operations (PCO). The need for embarked UAV surveillance capabilities, and thus the FIRE SCOUT VTUAV program, continues unabated:

[65] Houseman, 3-4.

> Within the context of a PCO in an unplanned area of crisis or open conflict, the organic UAV capabilities that an ARG commander brings with him may be the operational commander's best (and only) intelligence asset for several days.[66]

The need to retain control of embarked UAV assets is imperative as the primary means of maintaining localized situational awareness in support of Operational Maneuver from the Sea and basic Force Protection requirements. In the future, as UAV capabilities increase, so will possible Joint Forces Air Component Commander requirements for their Control. This desire for control will be especially strong for UAVs that have laser target designation equipment, as will be the case with FIRE SCOUT VTUAVs.

Laser target designation capabilities have proven to be a valuable commodity, especially in Combined or Coalition operations where the number of foreign-contributed combat aircraft able to "laze" targets is seriously limited. Once operational, the FIRE SCOUT VTUAV must remain with ARG/MEU units throughout all phases of the amphibious mission – providing constantly-updated situational awareness in the littoral environment. The operational concept should not be altered. "Vertical takeoff and landing UAVs (VTOL-UAV) will support maritime

[66] Morris, 14.

operations."[67]

Conclusion

Our amphibious forces have been deploying for far too long without the necessary organic UAV surveillance support they deserve. Manned aircraft simply cannot compete with modern UAV technology in the area of long-dwell surveillance coverage. The gaps in responsive coverage inherent even with dedicated, manned surveillance assets should be argument enough for aggressive acquisition and utilization of VTUAV capabilities for littoral operations.

While the FIRE SCOUT VTUAV is definitely a much-needed step in the right direction, it should only be considered an interim solution for the critical surveillance mission. Just as there is little doubt that the FIRE SCOUT will eventually be used in several important littoral missions, the need for a follow-on VTUAV with dedicated long-dwell surveillance/flight endurance, superior to the FIRE SCOUT's maximum six hours, should be clear. With other current UAV designs regularly achieving 30-hours flight duration, a viable VTUAV design offering on-station dwell time far beyond that of FIRE SCOUT's converted manned helicopter airframe should not be too far in the future.

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[67] LCDR Thomas B. Lukaszewicz, USN, *Joint Doctrine And UAV Employment*, (Newport, RI: Naval War College, 1996), 4.

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