

Control of Marine Unmanned Air Vehicles:
Concepts for Unmanned Aircraft Systems
Family of Systems Command and Control in
Amphibious Operations

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INTRODUCTION

Unmanned air vehicles (UAVs) have been mitigating risks since February 1863, when Charles Perley used an alarm clock timer linked to bomb bay doors on a hot air balloon to drop ordnance behind enemy lines in the Civil War.¹ The desire to wage war with tools that mitigate risk to human life and that are resistant to environmental, physical, and mental stresses of combat has led to the growth of unmanned technologies. Today's UAVs fly from as low as 500 feet to altitudes in excess of 95,000 feet, and vary in weight from less than a pound to thousands of pounds. Furthermore, advances in communications and control have extended the operational range of UAVs beyond what had ever been imagined. Unfortunately, the Marine Corp's amphibious doctrine has not kept pace with employment of UAVs in the amphibious operations area (AOA). The Marine Corps must develop amphibious command and control, facilities and training for the organic Marine unmanned aircraft systems family of systems (UASFoS) to optimize UASFoS' role in amphibious warfare and to reduce the increasing danger to friendly and neutral civilian entities.

¹ Pearley, Nov 2002, < www.pbs.org/wgbh/nova/spiesfly/uavs.html >.

BACKGROUND

As the capability of the UAV grew, so too did the demand for its services. The Global War on Terror (GWOT) demonstrates the proliferation of the UASFoS that include air vehicles, pilots, and ground control stations. Marines UASFoS pilots reported that RQ-2 Pioneer UAV flight hours increased from pre 9/11 rates of 1,000 – 2,000² hours per year to post 9/11 rates of 1,000 – 2,000 hours per quarter.³ Indeed, the U.S. Marines are not the only American service that has increased its reliance on UASs. Use of armed predators has been well publicized:

“Opening up a visible new front in the war on terror, U.S. Forces launched a pinpoint missile strike in Yemen, killing a top al-Qaeda operative in his car . . . Qaed Salim Sinan al-Harethi . . . struck by a Hell-fire air to ground missile . . . from pilotless Predator aircraft.”⁴ Also, in May 2005, a CIA Predator drone aircraft fired a missile, killing Haithem al-Yemeni, whom U.S. intelligence had been tracking for some time.⁵ Proliferation of UAVs, combined with the demand for their services, complicates aviation command and control by congesting joint use air space and is further complicated by civil aviation throughout Iraq and Afghanistan. “On a typical day, about 100

² Office of the Secretary of Defense, *OSD UAV Reliability Study*, Feb 2003, Appendix E.

³ PMA 263 2007, <<http://uav.navair.navy.mil>>.

⁴ *US Kills al-Qaeda Suspects in Yemen*, 11 May 2002, <http://www.usatoday.com/news/world/2002-11-04-yemen-explosion_x.htm> (05 April 2007).

⁵ Dan Priest, *Surveillance Operation in Pakistan Located and Killed Al-Qaeda Official*, 15 May 2005, <<http://www.washingtonpost.com/wp-dyn/content/article/2005/05/14/AR2005051401121.html>> (12 May 2007).

aircraft, about one-third of them unmanned, pass through the 30-mile square above Baghdad, about twice as many as last year. Up to 40 are in the air at any given moment, severely straining the air-traffic control system. And the congestion is getting worse as the military's fleet of UAVs expands, and U.S. forces work harder to quell unrest in the capital city."⁶

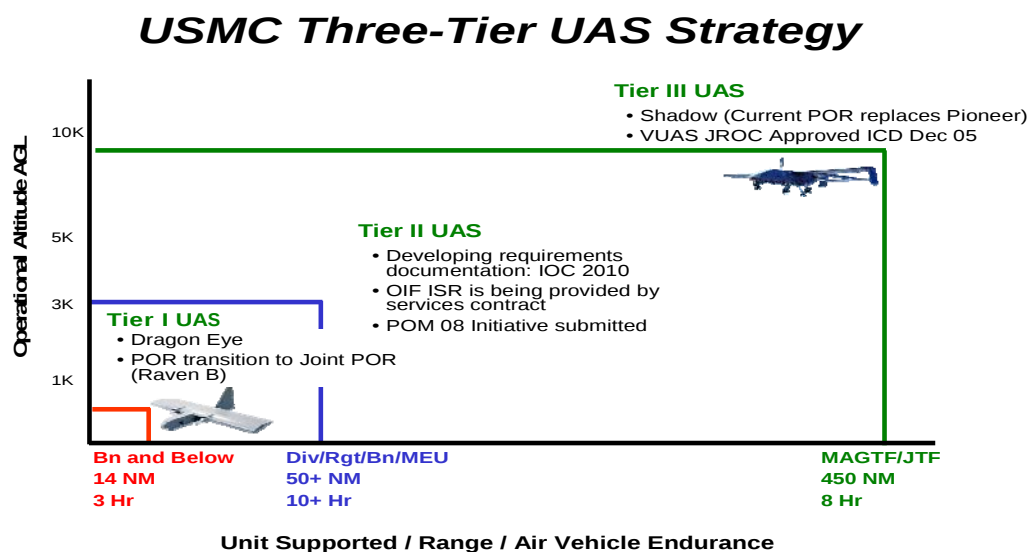


Figure 1 the three tier UAS Family of Systems⁷

This chart illustrates the family of systems concept of organization and belies future procurement and employment. Analysis of alternatives for each tier will ensure minimum operational coverage gaps and maximum mission fulfillment tempered by the lowest possible acquisition costs.

⁶ Gail S. Putrich, *Unmanned and Dangerous: How UAV Plane Collisions are Changing US Air Control*, 11 June 2007, < <http://integrator.hanscom.af.mil/2007/June/06142007/06142007-20.htm>>, (12 May 2007).

⁷ United States Marine Corps Marine Combat Development Command, *Unmanned Aircraft Systems Family of Systems Concept of Operations*, 2006, Appendix C.

FROM THE SEA 2015 AND BEYOND

COMMAND AND CONTROL

Security and sustainment operations have distracted the Marine Corp from developing amphibious command and control of UASFoS. Managing UAS operations is similar to managing manned aircraft with one exception, a UAV does not make real time C2 decisions. In the Corps, air direction/control and commander's intent are key to making real time decisions. "Purpose of air direction is to achieve a balance between the use of the MAGTF's finite UAV assets and the ability of the VMU [Marine Unmanned Aircraft Squadron] to accomplish its mission."⁸ "Control is the means through which the commander extends his authority."⁹ The UASFoS concept of operations refers to five levels of control of air vehicles. These control levels are depicted in Table 1.¹⁰ The table infers that equipment technology increases, and the responsibility placed on the entity controlling the UAV increases as the control level increases. In manned aviation, the commander would have a mechanism that allows him to delegate the appropriate control level to units with the required training and equipment. Many may argue that UAS C2 is not

⁸ United States Marine Corps Combat Development Command, *Unmanned Aerial Vehicle Operations*, Marine Corps Warfighting Publication 3 – 42.1, pg. 12.

⁹ United States Marine Corps Combat Development Command, *Unmanned Aerial Vehicle Operations*, Marine Corps Warfight Publication 3 – 42.1, pg 16.

¹⁰ United States Marine Corps Combat Development Command, Appendix C.

different from manned aviation C2. Herein lies the crux of the amphibious UAV C2 doctrinal dilemma – neither manned aviation C2 is not applicable to UAVs nor does an legitimate UAS amphibious C2 model exist!

Table 1
Levels of Control

Control Level	Functionality Provided
One	Indirect receipt and direct retransmission of imagery and/or data
Two	Receipt of imagery and/or data directly from the UAS, in addition to the functionality of previous level
Three	Control of the UAS payload in addition to the functionality of previous levels
Four	Control of the UAS, less takeoff and landing, as well as the functionality of previous levels.
Five	Full functionality and control of the UAS from takeoff to landing.

Direction and control of Marine UASs in the AOA require a shift in beliefs from the SASO environment to the amphibious environment. Iraq and Afghanistan's mature airspace and airspace procedures will be forgone luxuries at the outset of an

amphibious operation. In the SASO environment, all Marine UAV missions are controlled by the VMU. The author has not found an example of a VMU capability operating in the AOA.¹¹ Regardless, Marine UASFoS C2 afloat must facilitate rapid decision-making and responsiveness. Simply breaking UAV missions into “time critical” or “sensitive” operations may help organize UAV operations in the AOA. Due to any number of military or political reasons, the ACE commander or his representative may retain level four control of a mission to streamline decision making.

An example of streamlined UAS decision making is air direction residing with the senior Marine in the Navy TACC, while air control is delegated to the senior Marine in the VMU liaison detachment during amphibious operations. (A VMU liaison detachment would be a change to the existing organization of the Navy TACC and will be addressed later within this text.) This analogy draws upon the practice of divert authority. Divert authority allows a controlling agency to re-task an aircraft dynamically *if* certain conditions, pre-determined by the ACE CO, are met. Whether the ACE CO exercises air direction or divert authority, the appropriate level of Marine oversight and Marine technical expertise associated with the UAV mission is

¹¹ Since March of 2007, in countless discussions with senior Marine officers, staff, veterans of operations Desert Storm, Desert Shield, and Restore Hope, the author has not found a single example of Marine UAS flown from an amphibious ship. The Navy flies UAS from ships.

guaranteed. Without the Marine UAS liaison cell in amphibious operations, Marine UAS employment is left to the discretion of the Navy.

Controlling UASs afloat is normally the responsibility of Naval aviators.¹² If the Corps is going to be successful integrating UASs into the sea base, a commitment to manning the Navy TACC with a UAV liaison cell is the top priority. Those whom pose arguments against committing UAV personnel must heed the Commandant's, General Jim Conway, direction. General Conway directed the Marine Corps to return to its amphibious roots. The cell should consist of officers and senior staff non-commissioned officers skilled in air space management *and* employment of UAVs. Recommended positions include mission commander, airspace expert, crew commander, and one communicator. The key here is that experienced Marines capable of performing each other's jobs make up the UAV liaison cell. These trusted Marines should advise the commander on UASFoS C2 constructs, capabilities/limitations afloat and ashore, and UAS employment options. This cell would aid in the Marine Corps rapid planning process and provide leadership with an "ace-in-the-hole" UAS team.

¹²United States Navy and Marine Corps, *Ship to Shore Movement*, Naval Warfighting Publication 3 – 02.1 and Marine Corps Warfighting Publication 3 – 31.5, pg. 5.4.2.

FACILITIES

UAV Operations MCWP 3-42.1 specifically references that the Corps will continue to focus its efforts towards amphibious operations and all other missions and task in or around littoral areas . . . UAV systems should be organized to provided scalable support . . . UAV systems must be responsive to the needs of the MAGTF CO.¹³ One would think countless examples of Marine UAS employment in amphibious operations exist given the importance of this type of warfare to the Corps; however, none have been found. A concept of support for the Marine UASFoS must be developed if the Corp's UASs are going to meet their full potential in the AOA. If the Marine Corps is to attain the goals outlined in *UAV Operations MCWP 3 - 42.1*, a significant investment in resources must be made immediately.

Marine UAS hardware aboard ship presents an ideal investment opportunity. Every unit embarked aboard ship requires some level of support from that ship, from food and water to power and berthing. Following are three proposals for Marine UASFoS facilities ordered from least dependant to most dependent upon the seabase:

¹³United States Marine Corps Combat Development Command, *Unmanned Aircraft Vehicle Operations*, Marine Corps Warfighting Publication 3 - 42.1, pg. 1 - 4.

"Alternative One" envisions a seabased stand-alone ground control station. Here, the UAS detachment retains tactical flexibility, or the capability to operate independently of the seabase; however, "Alternative One" consumes berthing space and power which are limited while afloat. Finally, the alternative adversely impacts expediency due to a large logistics footprint.

"Alternative Two" can be conceptualized as the link to Navy hardware. One can visualize "Alternative Two" as a Marine using universal serial bus (USB) technology to plug into the Navy TACC remotely. Theoretically, the Marine would simply operate side by side with a sailor. "Alternative Two" economizes berthing space and minimizes power consumption; however, it creates hardware compatibility considerations and assumes that the Navy TACC has space available for Marines to "plug and play."

"Alternative Three" finds Marines operating from existing workstations in the Navy TACC. The third alternative assumes that the Navy TACC has allocated hardware for Marines and that all like UAS software applications are loaded and operational. Nevertheless, "Alternative Three" is the most expedient of the three alternatives and does not impact power or berthing.

These experimental alternative C2 organizations are theorized for specific mission requirements and provide C2 organization options for amphibious battle staffs of the future.

TRAINING

Five concurrent actions take place as UAS phase ashore: air vehicles are being launched and recovered at sea, air vehicles are flying in support of missions within the AOA, air vehicles are flying in support of missions ashore, and UAS detachments take part in the assault ashore while C2 phases ashore. These concurrent actions are a quantum leap ahead of the coordination required in the non-linear SASO environment.

Think of the SASO environment as a circular battlespace while the AOA airspace is linear. The linear example contains just as many if not more aircraft, in half of the area! Transferring control of the UAV during amphibious operations is a place where information bottlenecks will occur; and matching an AV's control level to a Marine's skill set in the AOA will be a source of friction. In the UASFoS, the pilot to air vehicle ratio is fixed, and the air vehicle to ground control station is fixed. One can infer, based on the threat, that demand for UAS support will exceed air vehicle supply during amphibious operations. Currently nothing circumvents the UASFoS ratios.

Today AVs are flown on pre-programmed flight plans within line of sight of their ground control stations. The AV is simply on autopilot just as any manned aircraft can be flown on autopilot. If training and equipment existed to embrace autonomous flight in the future, a situation could/would exist in which an AV could fly beyond the range of the UASFoS!

To fly beyond line of sight constraints, amphibious UASFoS training must equip AV operators, such as forward observers, with remote video terminals capable of the five levels of control. An AV operator with full control capability ashore no longer requires line of sight with the sea-based AV pilot. Instead the autonomous AV flight capability requires enhanced remote video terminals, AV operators trained in AV flight programming, airspace design, and airspace control measures. This capability can extend the stand-off range of the sea base with respect to UASFoS.

As the AV flies with impunity within the safety of the airspace, the sea-based AV pilot can concentrate on higher priority tasks while the forward observer concentrates on utilizing his remote video terminal display to aid in fighting the enemy. In the event the sea-based pilot needs to regain immediate control of the AV, he simply uses the C2 architecture in place to assume control. Autonomous flight hinges upon certain levels of equipment technology and operator training.

CONCLUSION

"Speaking at an October 2005 conference in Washington, then-Lt. Gen. Buck Buchanan, who commanded Central Command Air Forces, said that Army and Marine UAVs had collided with helicopters, but not fixed wing aircraft. And he stressed that it was only a matter of time before a manned plane would crash after hitting a UAV too small to be tracked by radar. One of these UAVs could bring down a C-130 transport, killing all aboard, Buchanan told the audience."¹⁴ While the Marine Corps' UAS will have some growing pains, they will present an even greater number of opportunities. Future UAV amphibious doctrine should consider how commanders will tackle UAV command and control. Incorporating a UAV liaison cell with the Marine/Navy TACC will aide both the Naval and Marine Commander in making sound UAV decisions. The UAS liaison is designed to advise Commanders how to employ the three alternative UAS facility proposals. Finally, properly trained AV operators could direct autonomous UAS control to maximize the UAS Family of Systems.

Marine UASFoS are integral to the realm of military operations, especially amphibious operations. If Marine UASFoS impacts in all areas of military operations are not closely

¹⁴ Gail S. Putrich, *Unmanned and Dangerous: How UAV Plane Collisions are Changing US Air Control*, 11 June 2007, < <http://integrator.hanscom.af.mil/2007/June/06142007/06142007-20.htm>>, (12 May 2007).

managed, the great number of positive impacts that UASs bring will be erased by danger of mishap, or valuable products will go unused from a lack of availability and fusion. Optimizing UAS contribution, while simultaneously mitigating the risk that they present to other Warfighting activities is something that must predate large scale UAS operations; amphibious or otherwise.

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