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This paper will address the employment of UAVs and their impact on the operational commander. This author believes that technological advances continue to improve the capabilities and reliability of the UAV. These platforms are able to provide 24-hour surveillance of the battlefield and a limited self-contained strike potential to the operational commander while reducing the support structure required for manned aircraft. UAVs will ease the high operational tempo of our LD/HD assets and allow these aircraft to be deployed in a more predictable fashion. Further, the increased use of UAVs will reduce the risk to coalition aircrews now performing these presence and monitoring missions, greatly enhancing the ability of the operational commander to utilize these assets to their fullest potential. This paper will begin with a short history of the UAV and continue through their use in Operation Iraqi Freedom. Current systems capabilities and limitations will be discussed. Operational functions that can be performed and the benefits to the operational commander will be detailed. Lastly, we will investigate some recommendations for future development and employment of UAVs.

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NAVAL WAR COLLEGE
Newport, R.I.

From Persistent ISR to Precision Strikes:

The Expanding Role of UAVs

by

John L. Trefz, Jr.

LCDR, U.S. Navy

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Contents

Introduction……4

The History/Background of the UAV……6

Current Operational Capabilities/Limitations……8

Benefits to the Operational Commander (Operational Functions) of UAVs……...12

Persistent Intelligence/Surveillance/Reconnaissance (ISR)……...……...12

Command and Control Warfare (C2W)……14

Limited Precision Engagement/Time-Critical-Targeting (TCT)……...15

Force Protection…….16

Recommendations……....17

Conclusion……...18

End Notes…….20

Bibliography……22

FROM PERSISTENT ISR TO PRECISION STRIKES:

THE EXPANDING ROLE OF UAVs

Introduction

Situational Awareness (SA) is a primary key to success in military operations. To achieve the desired level of SA and get it to the operational commander in a timely manner, we currently employ a variety of systems that cover only limited areas for limited times of the day. Many of these systems are considered Low Density/High Demand (LD/HD) assets and are expensive to procure and employ. Additionally, these manned platforms require vast support systems while conducting their missions. Taken together, these considerations greatly reduce the ability of the operational commander to maintain his desired level of SA over his area of interest. By developing highly reliable, unmanned platforms for long duration intelligence, surveillance and reconnaissance (ISR) missions, we can increase the flow of information to the operational commander enhancing overall battlefield awareness.

In order to fill this need, the Department of Defense has turned to the Unmanned Aerial Vehicle (UAV). During the 1990s, DoD invested over $3 billion in UAV development, procurement, and operations; since 2000, it has invested another $1 billion and will likely invest over $10 billion by 2010.[1] In a time of decreasing defense budgets and increasing military tasking, there is widespread support to continue the current trend of increasing UAV funding. Rep. Curt Weldon (R-Pa.), chairman of the House Armed Services Committee's military procurement subcommittee, has stated that Congress intends to make one third of America's tactical aircraft UAVs within 10 years.[2] Currently, some 32 nations are developing or manufacturing more than 250 models of UAVs, while 41 countries operate

some 80 types of UAVs, primarily for reconnaissance.[3] The potential for continued development is evident.

Current operational systems such as the Pioneer, Predator (both armed and unarmed), Hunter, Shadow, Dragon Eye, and Global Hawk have been used during Operations Enduring Freedom and Iraqi Freedom for a variety of missions previously performed by manned platforms. It is the opinion of this author that the addition of UAVs to the toolbox of the operational commander will enhance his ability to maintain theater-wide SA at an acceptable level. Further, as UAV technology develops, the potential missions and roles of the UAV will expand. UAVs will be called upon to tackle those mission areas commonly categorized as "the dull (reconnaissance), the dirty (nuclear, biological, chemical assessments), and the dangerous (suppression of enemy air defenses)."[4]

This author believes that technological advances continue to improve the capabilities and reliability of the UAV. These platforms are able to provide 24-hour surveillance of the battlefield and a limited self-contained strike potential to the operational commander while reducing the support structure required for manned aircraft. UAVs will ease the high operational tempo of our LD/HD assets and allow these aircraft to be deployed in a more predictable fashion. Further, the increased use of UAVs will reduce the risk to coalition aircrews now performing these presence and monitoring missions, greatly enhancing the ability of the operational commander to utilize these assets to their fullest potential.

This paper will address the employment of UAVs and their impact on the operational commander. It will begin with a short history of the UAV and continue through their use in Operation Iraqi Freedom. Current systems capabilities and limitations will be discussed. Operational functions that can be performed and the benefits to the operational commander

will be detailed. Lastly, we will investigate some recommendations for future development and employment of UAVs.

The History/Background of the UAV

The use of UAVs dates back to the American Civil War. Both Union and Confederate forces employed balloons laden with explosives with the intent of landing behind enemy lines and damaging any infrastructure that happened to be in the area.[5] The Japanese, over 80 years later, tried the same technique during World War II to land incendiary balloons in the Pacific Northwest to cause panic and mayhem within the United States. While innovative at the time, both of these attempts provided little success due to lack of positive control once the delivery platform was released. These delivery methods were quickly abandoned.

World War II saw the first use of powered aircraft in the UAV role. Called drones, these aircraft took off manually and the pilot bailed out once the aircraft was stabilized in flight. Now unmanned, these aircraft under remote control from another aircraft were flown directly into their targets resulting in the destruction of the delivery platform and hopefully the intended target. Although more akin to today's cruise missiles, the common theme with these early UAVs was the strike mission vice any attempt at ISR. The radio control technology of the time did not allow for the more precise control required delivering weapons and returning these UAVs to their bases for further tasking.

UAV development stagnated until the early sixties when two events rocked the U.S. Intelligence world. The May 1960 shoot down of Air Force Captain Gary Powers' U-2 reconnaissance aircraft over the Soviet Union followed by the loss of another U-2 during the

October 1962 Cuban Missile Crisis highlighted the urgent requirement for a more risk adverse reconnaissance gathering method.[6] This need to reduce the overall risk to U.S. pilots led to the development of the country's first operational UAV, the AQM-34 Lightning Bug. During the Vietnam Conflict, the Lightning Bug flew 3435 operational sorties with an 84% successful vehicle return rate.[7] While the preponderance of missions were related to photo reconnaissance, the "Bug" performed Electronic Intelligence (ELINT), Electronic Counter Measures (ECM), and Communications Intelligence (COMINT), as well as Psychological Operations (PSYOPS) leaflet dropping. The successful expansion of the operational capabilities of the UAV set the tone for future development.

In 1971, the U.S. Air Force received a mandate from Congress to demonstrate the ability for a UAV to deliver standoff weapons.[8] Within a year, a Lightning Bug drone successfully launched an AGM-65 Maverick missile and dropped an electro-optical glide bomb under development, but was never used operationally in this capacity.[9] While the AQM-34 proved the versatility of the UAV concept, continued interest after Vietnam did not materialize, and the vehicles were retired.

The UAV came of age during Operation Desert Shield/Desert Storm. The Israeli designed, Navy and Marine Corps operated Pioneer was the only UAV in operation during the conflict. These systems provided Battle Damage Assessment (BDA) during naval gunfire support missions for the battleships operating off the coast of Kuwait. They mapped potential minefields and possible landing areas for amphibious operations. Forty-three Pioneers flew 330 sorties during the Gulf War, amassing more than 1000 flight hours.[10] In one of the most remarkable incidents in UAV history, Iraqi troops on Fhalaka Island recognized the presence of a Pioneer UAV as the precursor to naval bombardment by 16-in.

gunfire and surrendered without a shot being fired.[11] Since then, the operational commander has been calling for increased UAV employment in his AOR.

Operations Allied Force, Enduring Freedom, and Iraqi Freedom have seen significant participation from UAV squadrons. The Predator saw its initial combat deployment during Allied Force as an ISR platform and provided continuous coverage of selected high-interest areas. Although very successful in this role, there were some growing pains in the process. The images from the Predator were not directly available to the various strike platforms, resulting is some difficulties while coordinating subsequent attacks. Air Force Chief of Staff, General John Jumper, in his remarks to the Naval War College in April 2003, stated that: "if he can see the target, why not have the ability to attack the target with the Predator and cut out the middle man." During Operation Enduring Freedom, his vision was realized with the first combat release in February 2002 of a Hellfire missile from the Predator. Additional combat releases have continued to this day. With the addition of the Global Hawk, the UAV has arrived and will be a critical asset to the operational commander in the future.

Current Operational Capabilities/Limitations

"Currently, the U.S. military is using more than 10 types of unmanned aerial vehicles to support operations in Iraq."[12] While the aforementioned quote sounds impressive, only two types of UAVs are operating in support of the operational commander. These are the RQ-1A/B Predator and the RQ-4A Global Hawk. Joint Publication 3-55.1 discusses the Joint Tactics, Techniques, and Procedures for UAVs. This publication discusses that while U-2/TR-1 reconnaissance aircraft and satellite systems are national assets and must be requested by the operational commander from the National Command Authority (NCA), UAVs are

considered organic assets and can be tasked as they see fit. This flexibility is critical for the operational commander to maintain and improve his overall SA.

High technology air surveillance and command and control aircraft such as the E-3 AWACS, E-8 JSTARS, and the C-130 ABCCC provide the operational commander with a near-real-time air, sea, and ground picture for command and control of forces in the AOR.[13] While these manned LD/HD assets possess phenomenal capabilities for the operational commander, they also have some serious limitations. Manned aircraft can remain on station for only so long. Once the mission exceeds 10 to 12 hours, crew fatigue will take its toll. Additionally, sustained operations over a period of days, weeks, or months will require a crew-to-aircraft multiple of about 3:1. Some aircraft with specialized aircrew such as linguists will be hard to man on a continuing basis. During Operation Allied Force, there were only enough specialists to fully man two RC-135 Rivet Joint crews. By removing these highly trained personnel from the brief/flight/de-brief cycles of up to sixteen hours with mandatory crew rest intervals in between, and instituting a watch cell monitoring the same signals from ground stations controlling UAVs, we can significantly reduce the demands placed on their time. In Operation Desert Storm, only two E-8 JSTARS aircraft were available. Significant maintenance downtime would impact the 24/7 coverage capability of this asset. The UAV provides an additional capability to the operational commander to conduct day or night reconnaissance, surveillance, and target acquisition (RSTA), rapid BDA, and battlefield management in high threat or heavily defended areas where the risk to high-value, manned systems is unacceptable and near-real-time information is required.[14] Although less capable than the manned aircraft they augment, they would fill the gaps in coverage required by the operational commander.

The RQ-1A/B Predator has continued to prove its worth in combat since first introduced in Operation Allied Force. Controlled by a pilot and two sensor operators, the addition of a Hellfire missile has made this a very potent sensor available to the operational commander. Most of these units are being loaded with a Multispectral Targeting System (MTS) that combines numerous targeting sensors into a single sensor package.[15] The Predator also has the capability to carry a Synthetic Aperture Radar (SAR) for employment in smoke, clouds or haze but cannot carry both sensors at the same time.[16] With the addition of Hellfire missiles, the ability to employ the "sensor as the shooter" eliminates delays and errors in target coordinate transmission.

The RQ-4 Global Hawk first saw action during Operation Enduring Freedom. Designed to remain on station for more than 24 hours, it has the capability to simultaneously employ sensors across all spectrums. Unlike the Predator, it flies a computer-controlled course but can be retasked in flight. With a payload of nearly 2000 pounds and endurance of up to 36 hours, it can operate at ranges of up to 3000 nautical miles at altitudes up to 60,000 ft.[17] Unlike the U-2/TR-1 manned system, the Global Hawk does not require the extensive support package of fighters, tankers, and electronic warfare assets when it flies into the AOR.

While both the Predator and Global Hawk offer substantial complementary capabilities to manned aircraft, there are some serious limitations that must be addressed. As with any new technology, there have been some growing pains with the employment of UAVs as well. Joint doctrine must be developed to integrate these assets into the common operational picture while deconflicting airspace between manned and unmanned systems.

One of the most troublesome obstacles to overcome is the availability of suitable satellite bandwidth. In today's net-centric warfare, everyone is competing for bandwidth.

Current UAVs require extensive satellite capacity to transmit live video back to the operational commander. Although available in small numbers today, we were still limited by satellite and ground control station availability to three systems at a time (one Global Hawk and two Predators) during Operation Enduring Freedom. In the future, to effectively "swarm" enemy defenses, the ability to employ tens or hundreds of UAVs may be required.

Weather plays a large factor in UAV operation. While the Global Hawk is advertised as an all-weather system, it is not as robust as the manned aircraft it supports. Predator on the other hand is a "fair weather" bird. It cannot fly in visible moisture and has much more restrictive take-off and landing limits than manned aircraft. Additionally, the Predator flies at 65-70 knots. If you are going against the wind, you may not get to your target for quite some time. Global Hawk flies at about 350 knots so it would not be affected as much.

Lastly, UAV reliability and sustainability is an important factor in the equation. Unmanned aircraft do not have the ability to recover from minor emergencies nor do they contain the redundant systems of manned platforms. While this has reduced the cost, size, and complexity, it has also reduced the margin for errors on the part of the controllers and equipment. Accident rates for all models of UAVs are up to ten times those for manned aircraft.[18] As technology continues to develop, these rates have dropped, but there is still a long way to go. With the Global Hawk, when one of the two aircraft crashed during Operation Enduring Freedom, the operational commander lost 50% of his assets.[19] Once we field more assets, the effect of these losses will be lessened, but at $10 million per unit, how many can we afford to lose? Predator has experienced two losses in Operation Southern Watch since 1998. Although less costly than the Global Hawk, these losses have cut the

operational inventory in theater by 25%. A DoD-wide effort to reduce non-combat losses will increase the future viability of UAVs.

Benefits to the Operational Commander (Operational Functions) of UAVs

Each of the Unified Commands, to identify and prioritize current shortfalls in warfighting capabilities, submits the Combatant Commander's Integrated Priority List (IPL) annually. Forty-two of the 117 (36%) requirements submitted in 2002 identified needed capabilities that could be filled with UAVs, with four specifying the UAV as the desired solution. These mission areas are listed below:[20]

- Force Protection
- C2/Comms
- ISR
- WMD
- Theater Air Missile Defense
- All Wx/Night Stk
- SEAD
- SIGINT
- ASW
- Counter Fire
- Exercise Support
- PSYOPS
- Counter Drug
- Meteorology
- Mine Warfare
- Navigation
- CSAR

Although ISR has been the predominant role of the UAV to date, there has been great progress in proving this platform in all these mission areas. Some of these will be discussed below.

<u>Persistent Intelligence/Surveillance/Reconnaissance (ISR)</u>

"Operational intelligence is directed at collection, analysis, and evaluation of information dealing with all aspects of the situation in a given theater of operation plus adjacent areas of interest."[21] The ability to gather timely, relevant intelligence is critical to

the success of any major operation or campaign. The capability to provide adequate coverage of the operational commander's Area of Responsibility (AOR) or Area of Interest (AOI) depends on the integration of both manned and unmanned assets. The level of effort will vary with the size (factor space) of the AOR/AOI and the time available (factor time) for intelligence collection.

During the pre-hostility stage of a conflict, UAVs can assist manned assets in the Intelligence Preparation of the Theater (IPT). Easily transportable and rapidly deployable, both the Global Hawk and Predator systems can quickly respond to an emerging crisis. Their smaller "footprint" in a given theater allows the operational commander to gather intelligence with less diplomatic and political interference. The deployment of manned platforms such as the JSTARS or Rivet Joint aircraft to monitor a given crisis results in a very large support package to sustain operations. Once these aircraft are in theater, Operational Security (OPSEC) becomes more challenging and Military Deception (MILDEC) may be lost. During the monitoring of adversary activity, the presence of easily identifiable, radar significant intelligence platforms makes easier the enemy's job of hiding his activities. UAVs' smaller size, combined with long endurance and unlimited sustainability, makes them the optimal platform during the pre-hostility phase of operations.

Once hostilities commence, the UAV remains the premier intelligence-gathering platform. The reduced risk to coalition aircraft and personnel in high-threat environments makes UAV employment ideal. Although systems such as the Global Hawk at $10 million per unit are not considered expendable, the cost of losing one of these assets is insignificant when compared to the loss of a manned asset and its aircrew. The ability of UAVs to

provide real-time BDA to the operational commander will allow more efficient allocation of follow-on strike assets to maximize their effects on the enemy's ability to continue to resist.[22]

Command and Control Warfare (C2W)

Information Warfare (IW) is the "actions aimed at achieving information superiority by denying, exploiting, corrupting, or destroying the enemy's information and information functions while protecting one's own from enemy attack."[23] C2W uses OPSEC, MILDEC, PSYOPS, Electronic Warfare (EW) and Physical Destruction to defeat the enemy's Command and Control (C2) functions while protecting one's own.[24] The UAV has the ability to accomplish all of these functions effectively.

As mentioned before, the employment of UAVs for monitoring and IPT missions improves both OPSEC and MILDEC activities. Additionally, the psychological impact to the enemy of constant monitoring and surveillance cannot be overlooked. The ability of the UAV to maintain 24/7 coverage of selected portions of the AOR will make it virtually impossible for the enemy to determine if or when he is being watched. The "CNN Factor" of constant coverage will make him think that all his movements are under scrutiny. When you add a limited strike capability to the UAV, such as armed Predators, the adversary commander would have to assume that all UAVs are armed.

Another subset of C2W is Electronic Warfare (EW). This is an area where the UAV can tackle the "dull" and the "dangerous" missions presently performed by manned aircraft. The three parts of EW are Electronic Attack (EA), Electronic Protect (EP), and Electronic Support (ES).[25] EA serves to deny the enemy's operational commander the use of the electromagnetic spectrum while EP serves to safeguard the use of the same spectrum for our

operational commander. ES involves those activities which serve to identify our enemy's activities and help locate the threats (SIGINT is a by-product). ES also helps to provide Indications and Warnings (I&W) to our forces of immediate threats or potential future threats enhancing overall Force Protection. The Global Hawk UAV is ideally suited for the mission of monitoring enemy electronic emissions and providing timely threat warnings to the operational commander. As UAV technology advances, they will prepare the battlefield by leading the way into high threat envelopes and neutralizing enemy air defense systems. As mentioned before, they are not expendable, but their loss would be more acceptable than that of a manned aircraft.

Limited Precision Engagement/Time-Critical-Targeting (TCT)

"Operational Fires are the application of firepower to achieve a decisive impact on the outcome of a campaign or major operation."[26] The capability of Limited Precision Engagement along with TCT for the UAV enhances the ability of the operational commander to conduct operational fires. These fires should not be confused with strategic bombing or tactical actions. They should have an impact on the entire theater. Today's Predator, armed with the Hellfire missile, has been used extensively in both Operation Enduring Freedom and Operation Iraqi Freedom to surgically neutralize selected targets.

Most of these attacks would be considered tactical in nature. An operational example would be the 27 March 2003 attack on a satellite dish at the Iraqi Ministry of Information that was being used for communication to dispersed Republican Guard units.[27] This attack affected the entire theater of operations. CIA controlled Predators have been used in Afghanistan and Yemen to eliminate suspected Taliban and al-Qaeda targets.[28] The ability of

the UAV to be both the sensor and the shooter condenses the time it would take to pass the coordinates and the possible transmission errors to another strike platform. It must be noted that today our UAVs are lightly armed and could not destroy heavy armor or reinforced concrete structures. Applying this scenario to the B-1B attack on Saddam Hussein during Operation Iraqi Freedom, an orbiting Predator could have potentially attacked the Iraqi leader as he entered or left the facility.

The ability of tomorrow's UAVs to deliver or direct the employment of both lethal and non-lethal operational fires will enable the operational commander to shape the battlespace, eliminating the enemy's ability to conduct offensive or defensive operations. Unmanned Combat Aerial Vehicles (UCAVs) under development such as Boeing's X-45 for the U.S. Air Force and X-46 for the U.S. Navy, as well as Northrop-Grumman's X-47 for the Navy, all possess lethal combat power for employment in those "dangerous" mission areas where the loss of manned aircraft is more likely.[29] With the Global Hawk or Predator acting as Forward Air Controller (Airborne), or FAC(A), with the ability to mark the target for visual delivery or pass target coordinates via datalink to orbiting UCAVs, the operational commander will have a valuable asset in his toolbox for years to come.

Force Protection

"Operational Protection pertains to a series of actions and measures conducted in peacetime, crisis, and war, and designed to preserve effectiveness and survivability of one's military and non-military sources of power deployed within the boundaries of a given theater."[30] The ability of the long-endurance UAV to provide timely and accurate I&W of

impending enemy actions will enable the operational commander the freedom of action he desires.

UAVs could be utilized for Harbor Defense and for Mine-Countermeasure Missions (MCM). Working in conjunction with ground-based anti-aircraft systems, they could fill the role performed by E-2 Hawkeye or E-3 AWACS aircraft for Air Defense and Air Control operations in rear operating areas, freeing up these LD/HD assets for operations in forward areas. By reducing the requirement for these LD/HD assets, operational tempo could be increased throughout the theater. Lastly, in the event of an attack on coalition forces using WMD, UAVs could be equipped with detection equipment and sent in to test for the presence of harmful effects ("dirty" mission) left by those weapons.

Recommendations

The following recommendations are provided for consideration:

- Increase satellite availability to ensure adequate bandwidth is available for UAV control. Continue development to control logarithms to reduce bandwidth requirements thereby allowing for increased availability and reliability of UAV systems to the operational commander.
- Increase UAV reliability and reduce accident rates to more acceptable levels enabling operational planners to employ the maximum benefits these UAVs offer to the operational commander.
- Continue incorporation of UAVs into those mission areas classified as "dirty" and "dangerous." Development of doctrine must be accelerated to determine when and where a UAV will replace a manned asset in a given task.

- Continue development and testing of armed Predators. Develop criteria where armed UAVs would replace manned strike systems. Define and develop Rules-of-Engagement for the application of this strike potential. Continue to explore alternative weapon systems and additional payload limits.
- Ensure that all UAV activity is incorporated into joint warfighting publications that are up to date and usable to the operational commander. Currently, Joint Pub 3-55.1 regarding UAV employment is 10 years out-of-date and needs revision.
- Educate Operational Commander's staffs as to the capabilities and limitations of today's UAVs as well as employment considerations. Include UAV subject matter experts on the staffs of all Combatant Commanders for early integration into the planning process.
- Continue development and testing of new concept UAVs such as the X-45/46/47 series to determine the feasibility of replacing manned aircraft in specific mission areas. Ensure this development is coordinated with the Combatant Commanders IPL with regard to specific mission tasks and functions desired by the end user.

Conclusion

In today's globally connected world, the advent of the worldwide web along with personal data assistants and cellular telephones, information proliferation has changed the shape of the battlespace we will encounter. In order to remain dominant, the operational commander must possess the most accurate and timely information available while denying his enemy the same. Today's ISR platforms are currently tasked to their limits with regard to personnel and machines performing remarkable work around the world. While the United States and its allies cannot be everywhere at all times to monitor a developing crisis,

increasing demands require additional capabilities. In order to augment our current ISR capabilities, the continued development and employment of UAV technology is required. The ability of the operational commander to increase his SA in a given region with or without an excessive buildup of personnel is provided by the flexibility the UAV offers. We must integrate unmanned and manned assets into a smooth working team to facilitate this requirement.

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