COMPARISON OF THE VALUE OF ATTACK AND RECONNAISSANCE CAPABILITIES OF UNMANNED AIRCRAFT SYSTEMS VERSUS MANNED AIRCRAFT FOR ARMY COMMANDERS AND INTELLIGENCE OFFICERS

by

Joseph D. Sage

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ABSTRACT

Researcher: Joseph D. Sage

Title: Comparison of the Value of Attack and Reconnaissance Capabilities of Unmanned Aircraft Systems versus Manned Aircraft for Army Commanders and Intelligence Officers.

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Unmanned Aircraft Systems (UAS) have revolutionized intelligence, attack and reconnaissance operations on the modern battlefield for the U.S. Army. However, the debate continues as to whether manned or unmanned aircraft can best serve the requirements of commanders and intelligence officers. Army pilots have refined the scout/attack and reconnaissance missions since Vietnam with techniques utilized ever since the origins of the U.S. Cavalry. Although the utilization of UAS is not new, their applications have been refined over the past nine years, during Operation Iraqi Freedom and Operation Enduring Freedom. This research; derived from the viewpoints and experiences of commanders, pilots and intelligence officers, validate that combining the strengths of UAS and manned aircraft can produce an exceptional force multiplying asset that will enable commanders and intelligence officers with an improved ability to make decisions, plan, limit risks and better protect the force while establishing dominance on the battlefield.

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CHAPTER I

INTRODUCTION

Background of the Problem

Although the utilization of unmanned aerial systems (UAS) is not new to the U.S. military, these systems have recently evolved into highly technologically advanced instruments that have become critical tools for commanders to carry out modern day reconnaissance and attack operations. The recent military successes of UAS in Operation Iraqi Freedom, Operation Enduring Freedom and in remote insurgent strongholds such as the western frontier of Pakistan have opened the eyes of many former critics to the benefits presented by these technologies. Unmanned aerial systems are now making national headlines as they assume missions and responsibilities that have traditionally been reserved for manned aircraft.

The current wars in Afghanistan and Iraq have proven that unmanned aerial systems have significantly augmented mission accomplishment, reduced soldier's workloads, and decreased their exposure to enemy contact. As we have seen in recent times, unmanned aerial systems have been successfully implemented in strikes against an asymmetric, insurgent enemy that thrives in environments that are considered too hostile for standard soldiers to occupy. Furthermore, unmanned aerial systems have served as a unique asset for commanders, by broadening their situational awareness (SA) on the battlefield and providing them with the ability to observe, target and destroy the enemy through Near-Real-Time (NRT), actionable intelligence delivered directly to their command posts.

The recent wars in Iraq and Afghanistan have established that UAS reduce risks to soldiers in combat, and decrease the workload of soldiers through taking on dangerous and time consuming missions (e.g. monotonous surveillance outside of the security of forward operating bases). Furthermore, UAS are enabling manpower to be focused on high tempo operations, and unmanned systems can be utilized for extended range or standoff reconnaissance and attack operations without putting armed forces at risk beyond the Forward Line of Troops (FLOT). The abilities of UAS are extraordinary. Mr. Robert Myers, a senior UAS instructor at the UASTB, stated that UAS can better handle the "Three Ds," referring to missions that are dull, dirty and dangerous (Myers, personal communication, August 21, 2010). Because of these attributes, unmanned aerial systems are becoming a favored asset in the arsenals of commanders. These new outlooks on UAS will forever change how the Army executes operations and plans strategies.

According to the John Warner National Defense Authorization Act (Public Law 109 – 364 – Section 941, page 282 of 489), passed by Congress in 2007, the following policies are required by the Department of Defense.

Table 1

Department of Defense Policies for Unmanned Systems

Identify a preference for unmanned systems in acquisitions of new systems.
Address joint development and procurement of unmanned systems and components.
Transition service-unique unmanned systems to joint systems as appropriate.
Establish an organizational structure for effective management.
Coordinate and budget for the development and procurement of unmanned systems.
Develop an implementation plan that assesses progress towards meeting goals established in Section 220 of the National Defense Authorization Act of fiscal year 2001, that by 2010, one-third of the operation joint deep strike aircraft of the armed forces will be unmanned.

Note. From Public Law 109 – 364 – Section 941, page 282 of 489

The drive by the U.S. Government is obviously leaning in the direction of pilotless aerial technologies to enhance the fleets of manned aircraft that conduct attack and intelligence, surveillance and reconnaissance (ISR) missions. Over time, it is speculated that UAS technologies will not only compliment manned fleets; but they will eventually replace them altogether. Keeping in step with the driving force of Congress, the U.S. Army intends to cash in on UAS capabilities to improve warfighter effectiveness with less risk. According to information papers released by the U.S. Army Aviation Center of Excellence (USAACE, 2010), over the next 25 years, UAS development, personnel, training and stationing facilities will be a primary focus of the Aviation Branch. The vision for Army aviation is to employ UAS across the operational environment, across functional areas and across the spectrum of operations as a key force multiplier. UAS are anticipated to extend Army capabilities in command and control (C2), lethality and eventually transport.

The Army Vice Chief of Staff directed the establishment of the U.S. Army Unmanned Aircraft Center of Excellence (UASCOE) at Fort Rucker, Alabama. The purpose of the center is to lead the Army's effort in synchronizing all Army unmanned aerial systems technology with the Department of Defense, functional Army proponents and industry stakeholders. UASCOE is responsible for being the integrating agency for all UAS related issues and serves as the single source and voice for all Army UAS strategies. More than just a focal point for U.S. Army UAS operations, it has become a military centerpiece for the development of UAS technologies and tactics. The mission statement of UASCOE is "to integrate UAS technology into the modern battlefield and to provide field commanders with decisive vertical and horizontal advantages over their adversaries in war."

Table 2

UASCOE Key Directives

Continue to develop flexible, coherent, comprehensive and actionable UAS strategy for the Army.
Synchronize the efforts of all UAS related issues that support current, emerging and future forces.
Serve as the executive agent for the Army UAS Board of Directors.
Chair the Training and Doctrine Command's (TRADOC) UAS Board of Directors Working Group to support and facilitate the development of the UAS Concept Capabilities Plans change requirements. Develop and implement the Army's UAS communications plan.
Represent the Army on national airspace integration, joint command and control, and spectrum management issues.
Represent the Army on UAS task force integration process teams.
Participate in UAS accident and mishap investigations, joint UAS experiments, exercises, simulations and studies
Represent the Army to joint, coalition and other U.S. Government and non-government agencies.

Note. Retrieved from USAACE at http://www.rucker.army.mil/usaace/uas/

The U.S. Army has been at the forefront of the experimentation, development and training of UAS technologies. In 2006, the 1st Battalion, 210th Aviation Unmanned Aircraft Systems Training Battalion (UASTB) was activated under the Army Aviation Branch to assume responsibility for training UAS operators and maintainers at Fort Huachuca, Arizona. Although

UAS research has been conducted on Fort Huachuca for nearly half a century, it was previously covertly veiled in black ops and then trained by the 111th Military Intelligence Brigade.

The UASTB is dispersed over 750 acres with training areas and support facilities that include three separate runways and 997 miles of restricted airspace. The battalion's mission is to develop, maintain and administer UAS operator training, maintainer training, the Tactical UAS Warrant Officer Technician Training program and the UAS Command and Staff Officer's Course. The goal is to provide ground force commanders with highly trained, combat ready Aviation soldiers and make available training to the other branches of the military as well. Specific airframes taught by the UASTB include the Hunter, Shadow, Warrior-A and the Extended Range Multi Purpose (ERMP) Gray Eagle UAS. According to the forecasted planning of the UASTB, there are approximately 2,000 soldiers trained annually and the Army has projected doubling these numbers in oncoming years. Clearly, the Army is dedicated to the implementation of UAS technologies to become a main staple of its strategies. The amount of money, time, personnel and equipment being devoted to carrying out the UASTB's mission is staggering and it's a true testament to the Army's commitment towards implementing UAS technologies.

Lessons learned in Iraq and Afghanistan validate the need for long endurance platforms that remain on station with precision strike capabilities, thereby reducing collateral damage, and facilitating time sensitive targeting of High Value Targets (HVT). The Army's focus is not only on smaller tactical UAS, but also is extending into the realm of larger unmanned aircraft with greater payloads and longer station times. For example, the Extended Range Multi-Purpose (ERMP) Gray Eagle UAS will provide an unprecedented capability of up to 30 hours station time, carrying an armament package of four AGM-114 Hellfire missiles, while simultaneously boasting a robust payload of synthetic aperture radar with ground moving target identification and real-time video feeds along with electro-optical and infrared imagery. Commanders and intelligence officers can access all this real-time. Furthermore, the ERMP can be controlled beyond line of sight via satellite or through aircraft relay by means of AH-64 Apache and OH-58D Kiowa helicopters. This potential by far exceeds any capabilities provided by current U.S. Army manned aircraft (Headquarters Department of the Army, 2010).

However, the advantages of human pilots are significant and cannot be overlooked by Army commanders and intelligence officers. War is a human endeavor, unpredictable and chaotic. Although UAS may be utilized as weapons of war, they can never become a warfighter themselves. For example, helicopter pilots are embedded, from an aerial perspective, in the fight alongside ground troops. A helicopter pilot's senses and instincts are directly involved with what is happening on the battlefield, whereas, comparatively speaking, a UAS operator has a disconnected and remote perspective of the battlefield. Moreover, although unmanned aerial technologies are advancing rapidly, they aren't capable of "thinking" and lack the instinct, judgment and reasoning that intuitive, motivated and experienced pilots provide from the heart of the fight. At best, a UAS operator can make an attempt to apply these attributes through the unmanned aerial system's optics remotely from a distance. There's a lot that even the most advanced technologies can't overcome; in particular, the "fog of war."

The greatest benefit of utilizing helicopter pilots is the human element on the battlefield for reconnaissance and attack operations by literally having eyes on the target while directly involved in the fight. This is an advantage that a machine can never provide. There is an unmistakable, tacit bond created by pilot's moral obligation and connection to the human beings that he or she is supporting and defending directly below. In particular, there is a bond of trust between the soldiers on the ground and the pilots in the sky supporting them. It is doubtful that soldiers will ever be as comfortable with a remotely operated machine as they are with a human pilot who they share the responsibility to fight in order to survive. Furthermore, in modern combat zones, pilots are constrained to many restrictions concerning exactly who, where and how to engage the enemy. The pilot's, up-close-and-personal, interaction in the fight only solidifies the necessity to maintain rules of engagement at all times. From my own combat experience, I've witnessed that even the most advanced UAS can lose sight of the priceless troops on the ground, the rules of engagement and the sense of urgency that can only be understood from a personal perspective attained within the fight. The survey results, of commanders and intelligence officers during this research, disclosed that it is arguable that a human pilot's senses and instincts are still the best tools for peering through the fog of war.

Nevertheless, along with the obvious benefits of having manned aircraft on the battlefield, there are also significant disadvantages. The most apparent is that reconnaissance and attack helicopter pilots must be exposed to enemy threats in order to find and fix the enemy. Under certain circumstances, the exposure of the helicopter pilots to the enemy may result in discovery and thus destruction. It is arguable that despite the advantage of having the human element from an aerial perspective, it's better to lose a UAS than an expensive helicopter or a priceless crew.

The crux of the argument is whether the remote, yet technologically advanced capabilities of UAS can provide intelligence officers and commanders a better product than manned aviation operations that have been refined since Vietnam. Although safety is obtained through distance, some could argue that no UAS will ever replace a human pilot's moral obligation and bond to the soldiers that he or she is supporting and defending directly in the fight below.

Researcher's Work Setting and Role

The researcher has considerable experience flying with the U.S. Army's helicopter attack/reconnaissance community and the U.S. Army's Intelligence fixed-wing community. The researcher has nearly 1,500 combined hours piloting the OH-58D helicopter, the Communications Intelligence (COMINT) RC-12 airplane and the Imagery Intelligence (IMINT) ARL/RC-7 airplane. Furthermore, the researcher has flown nearly 400 combat hours in Iraq piloting Kiowa Warrior helicopters and approximately 750 hours collecting intelligence in RC-12 and RC-7 airplanes along the world's most demilitarized zone between North and South Korea. Recently, the researcher has been working alongside UAS operators at the U.S. Army's only Unmanned Aircraft Systems Training Battalion as a Company Commander at Fort Huachuca, Arizona. The researcher's combat experience, Army Aviation intelligence operational experience and proximity to the Army's latest UAS technology allows for a unique perspective of the research and the ability to compare what the UAS versus manned reconnaissance and attack aircraft has to offer intelligence officers and commanders on the modern battlefield.

Statement of the Problem

During the past two decades, there has been an exponential rise in the utilization of UAS. The procurement and development of these technologies continues to grow rapidly and will expand throughout military operations in the future. One of the most divisive effects this technology has had on the aviation community is the utilization of UAS for roles that were previously carried out by manned aircraft; in particular, reconnaissance and attack operations.

The debate continues as to whether manned or unmanned aircraft can carry out these missions best. Presently, manned aircraft pilots conduct both reconnaissance and attack techniques that have been in practice since the origins of the Cavalry and refined since the Vietnam conflict. This paper sought to answer the question as to whether or not UAS can provide a better solution through safer, more efficient and less expensive alternatives to what has traditionally been provided by manned aircraft pilots within the armed attack and reconnaissance communities.

Significance of the Problem

The significance of the problem lays in determining the way ahead for Army Aviation in terms of whether UAS or manned aircraft provide the best Intelligence, Surveillance and Reconnaissance (ISR) and attack capabilities. The heart of the issue is whether or not technologically advanced UAS can provide equivalent or improved results for intelligence officers and commanders as manned aircraft have provided through the added benefit of the "human element." There is a dispute as to whether or not UAS can take on all of the capabilities and potential that human pilots can.

Human factors are at the core of the debate. Many reconnaissance and attack pilots maintain that there are conscious and subconscious senses that pilots employ on the battlefield that cannot be replicated remotely through UAS. In particular, a pilot on the battlefield not only has his or her life vested in the mission but is responsible to soldiers on the ground. Because of the proximity of being in harm's way and the immediacy to the fight, it could be argued that human pilots are more aware of what is happening on the battlefield than a UAS operator could ever be through remote control. The questions researched are whether or not intelligence and attack capabilities can be carried out from a significant distance from the fight via computer screens and television monitors and still provide commanders and intelligence officers the solution they need to carry out their missions.

Another factor to consider is cost, because it is oftentimes the great equalizer in military acquisition programs. Regardless of how capable a system may be, if its expenses can't be justified then it may never come to fruition. Presently, it is less expensive to maintain and upgrade current manned attack and reconnaissance aircraft. However, as fleets of aging aircraft near the end of their life span it may be cost-effective to replace these manned aircraft with UAS. Weighing the factors, there several dynamic issues that impact the procurement and development of UAS rather than the advancement of manned ISR and attack aircraft.

Despite all of the concerns that go into the acquisition of future aerial systems, the bottom line is whether or not we really want to set out into the direction of relying on fleets of unmanned aircraft to provide commanders and intelligence officers the solutions they need. Will this direction provide viable solutions or are we eliminating one of the best assets that we have over the skies of the battlefield…the human element?

We stand at the precipice of change. It was just 107 years ago that Orville and Wilbur left the ground in the Wright Flyer. Only 227 years ago, man first took to the skies in a Montgolfier balloon. In the grand scheme of things, mankind has only flown but a blink of an eye in comparison with our existence on earth. A lot of pride has gone into the accomplishments that have been achieved through manned aviation. Now, in the 21st century, we have refined the missions and capabilities of manned flight. Are we now in the days of the last of the manned pilots?

Limitations of the Problem

Today's technological advances versus the tactics, techniques and procedures utilized in military manned aviation define the scope of this research. Each technology was analyzed in detail, but only to understand how it may best be exploited on the battlefield. Furthermore, this research was defined by experiences of combat pilots compared to the experiences of UAS operators. The objective of this paper was to define what both systems, manned and unmanned, can provide commanders and intelligence officers in order to carry out their missions.

The target demographics for pilot acceptance research was intelligence officers and commanders in the United States Army and OH-58D Kiowa, AH-64 Apache pilots with experience levels ranging from 300 combat hours to over 3,000 combat hours flying reconnaissance and attack missions. All pilots surveyed have completed at least one tour in either Iraq or Afghanistan and were able to speak on the matters of reconnaissance and attack from personal experience. Furthermore, all UAS operators surveyed have experience levels ranging from 300 combat hours to over 3,000 combat hours in either Iraq or Afghanistan and are able to speak on reconnaissance and attack from personal experience as well.

Assumptions

It was assumed that the OH-58D Kiowa Warrior is one of the most close-to-the-fight manned aircraft on the battlefield today alongside the AH-64 Apache. The UAS operators involved in this research have been selected for their combat experience and knowledge of attack and reconnaissance operations.

Additionally, the following assumptions were used to define the UAS role within the reconnaissance and attack communities:

- Integration of manned and unmanned systems will increase capability across full spectrum operations.
- Industry will deliver the required technologies for combat system development within affordable constraints.
- Higher levels of autonomy, provided by UAS, will reduce risk to personnel.

CHAPTER II

REVIEW OF RELEVANT LITERATURE AND RESEARCH

This research paper draws on previous studies, literature and information relevant to the problem in order to provide a reference and to recognize the body of research that has preceded this proposal. This analysis centers on the value of intelligence, reconnaissance and attack capabilities of UAS in contrast with manned aerial assets for Army commanders and intelligence officers. A history of the development of the current manned systems utilized by the U.S. Army will be contrasted with the background and progression of unmanned aerial systems in order to examine whether or not UAS are nearing equality with the significance of what human pilots have bestowed on the battlefield.

Brief History of Manned Flight

People have embraced the dream of flight since the origins of man. This can be seen in the ancient Greek myth of Icarus and his father Daedalus, who attempted to escape death from the man eating Minotaur in King Minos' Labyrinth through flight. Clearly the perils of flight to man were obvious even thousands of years ago, as the story speaks of Daedalus screaming out to his son, warning him not to fly too close to the sun because the wax in his wings would melt causing him to fall perilously into the sea (Ovid, circa 135 C.E.). Perhaps humanity has come full circle in realizing the perils of flight, and its implementation of unmanned aerial systems are designed to remove the risks of flight on man?

The struggle to overcome man's boundaries to the earth continued through exploration, experimentation and imagination. In the 15th Century, Leonardo da Vinci wrote, "for once you have tasted flight you will forever walk the earth with your eyes turned skywards, for there you have been and there you will long to return" (Fort Rucker Aviation Museum). As far back as the renaissance, da Vinci created designs for a hang glider in which the inner parts of the wings are fixed, and some of the control surfaces were along the tips of the wings. Although most scholars don't believe that da Vinci ever flew, his concepts are recognized today as flight worthy. Even though a model he built for a test flight in 1496 wasn't successful, and some other designs, such as the four-person screw-type helicopter had flaws; a prototype, based on Leonardo da Vinci's Ornithopter was constructed in the twentieth century and successfully flew based on modern flight theories (Benedict, 2004).

Over the centuries, the dream of manned flight began to take fruition. In 1783, the French brothers, Joseph Michel and Jacques Etienne Montgolfier created the first unmanned hot air balloon and released it to an altitude of 6,000 feet and it traveled for more than one mile before descending back to the earth (Shaw, 2008). As Shaw wrote, after this successful experiment, the first manned flight, flown by Jean-Francois Pilatre de Rozier and Francois Laurent on November 21, 1783 was flown in a Montgolfier balloon.

In 1889, the German engineer, Otto Lilienthal, studied the aerodynamics of birds and applied it to gliders. He is credited as being the first person to design a glider that a person was able to fly for long distances. It was his writings that the Wright brothers drew from in order to find the inspiration for their airplane designs. The Wright brothers created the Kitty Hawk Flyer that flew one hundred twenty feet in twelve seconds on December 17, 1903. After the Wright's great accomplishment, Wilbur stated, "more than anything else the sensation is one of perfect peace mingled with an excitement that strains every nerve to the utmost, if you conceive of such a combination" (English, 2003, Page 4). During the next century, a seemingly infinite amount of airplane designs were developed based on this first flight at Kitty Hawk, North Carolina. Aviation has continued to blossom and grow, well beyond the imaginations of Leonardo da

Vinci or the Wright brothers. There was a time when it was argued that man could only fly in his dreams…try telling that to Neil Armstrong (Shaw, 2008).

History of Army Aviation

The roots of Army aviation can be traced back to 1861 with the formation of the Civil War-era Balloon Corps, which pioneered the missions of reconnaissance and artillery spotting. Between World War I and World War II, while the Army Air Corps was concentrating on increasing capabilities for what had become its primary missions—bombing, close air support, and air-to-air combat—the Artillery Branch was experimenting with using smaller, unsophisticated aircraft for adjustment of artillery fire. On June 6, 1942, the War Department authorized the Artillery Branch to have, as organic aircraft, two Piper Cub airplanes in each Artillery Battalion (Brown, 2000). These aircraft were flown and maintained by artillery personnel separate from the Army Air Force to continue the same mission of the Balloon Corps from the Civil War. This is considered the origins of the Army Aviation Branch.

In July of 1947, the U.S. military underwent a major reorganization. The Department of Defense was created and absorbed the War and Navy Departments. The three major elements of the military became the Army, Navy and Air Force. This action had little effect on Army Aviation. The Army, like the Navy and Marines, retained its organic aviation assets to perform the mission proven in World War II (Headquarters Department of the Army, 2006).

Of greater significance during the interim between World War II and Korea was the awakening interest in the helicopter. The Air Force had employed Sikorsky helicopters to a very limited extent, primarily for air rescue in the Far East in World War II. This, combined with technological advances in the helicopter, alerted the military to its greatest potential. During the Korean conflict, the helicopter proved to a battle worthy vehicle. The Army employed the Bell

H-13 with two external litters for frontline medical evacuation. Using the H-13s, the Army evacuated 21, 212 wounded servicemen in the Korean War (Headquarters Department of the Army, 2006).

During the 1950s, the Army began operating a fleet of reciprocating engine-powered aircraft including the L-19, L-20, U-1, U-8, OH-13, CH-19, CH-21 and CV-2. The UH-1B was introduced with makeshift armament flying as a Cavalry gun ship in Vietnam. Shortly thereafter came the UH-1D and H models, replaced the CH-19 and CH-21. The 1st Cavalry Division deployed with a full range of modern turbine-powered aircraft. Eventually, the OH-6 replaced the OH-13 and the AH-1G Cobras supplemented the UH-1B, C and M model gun ships. OV-1s and U-21s supplemented the fixed wing aircraft for intelligence collection missions and transport roles (Headquarters Department of the Army, 2006).

Created as a separate branch of the Army on April 12, 1983, the Army Aviation Branch has continued to modernize with new turbine-powered aircraft. The Army can be justly proud of its OH-58D, UH-60, AH-64 and CH-47s, which have performed admirably in Desert Storm, OIF and OEF. Furthermore, the Army has a dedicated fleet of RC-12 and RC-7 airplanes in order to continue modernizing intelligence missions throughout the globe (Headquarters Department of the Army, 2006).

Progression of Army Attack Operations

In the mid-1960s, the United States Army developed the concept of arming helicopters to face increasingly intense ground fire and provide aerial gunnery to ground forces during the Vietnam conflict. The use of UH-1 helicopter gunships proved that armed helicopters were vital in the role of providing support to Troops In Contact (TIC). The “Huey” was instrumental in laying down the theory of air cavalry operations, which enabled the U.S. Army to be highly mobile and lethal across a wide area of operations (Headquarters Department of the Army, 2006).

Closely related to the development of the Bell UH-1, the AH-1 Cobra was essentially an armed variant of the UH-1 model with a tailored, aerodynamic body and rotor system. Its conception was based on the premise that an armed attack helicopter could lead transport helicopters into hot landing zones, providing gunnery from the sky without the need of artillery or ground forces. AH-1 Cobras were utilized by the Army from the Tet Offensive in 1968 through the end of the Vietnam conflict. Moreover, Cobras were formed into hunter-killer teams with OH-6A and OH-58A scout helicopters. Cavalry tactics were developed in which Scout pilots would fly low and slow near to the ground probing for the enemy, until they drew fire from the enemy; at which point the Cobras would strike with overwhelming force. By the end of the Vietnam conflict, the Cobra airframe saw over one million hours of combat operations. AH-1 Cobras are still in use today by the U.S. Marine Corps (Headquarters Department of the Army, 2006).

Based on the lessons learned from the Vietnam conflict, the Army committed funds towards the research and development of a dedicated combat helicopter referred to as the Lockheed AH-56 Cheyenne Advanced Aerial Fire Support System (AAFSS) towards the end of the Vietnam conflict. However, as the political tide shifted during the Vietnam conflict, governmental support for the program dwindled until the program was cancelled on August 9, 1972. Nevertheless, the demand for an attack helicopter never ceased and a new advanced attack helicopter program was announced just one week later. After twelve years of development, the initial production of the AH-64A Apache was released and training of the first pilots began a year later. The first operational Apache unit was founded at Fort Hood, Texas and flagged as the 7th Battalion, 17th Cavalry Brigade (Headquarters Department of the Army, 2006).

In 1989, the Apache first saw combat during Operation Just Cause during the invasion of Panama, performing over 240 hours of attack operations at night through the use of Night Vision Goggles (NVGs). During Operation Desert Storm, Apaches were utilized in a deep strike mission to assist in destroying Iraq's air defense radar systems without being detected by enemy forces. Armed with Hydra rockets, Hellfire missiles and .30-millimeter cannons, the Apache squadrons destroyed over 500 Iraqi tanks, armored personnel carriers and other military vehicles. Only one Apache was shot down during the war. Despite being shot down by rocket propelled grenade (RPG), the crew survived and walked away from the aircraft relatively unharmed. Currently, the AH-64 has been utilized since 2001 in Afghanistan and Iraq, proving their worth as deadly, armored aerial attack assets to ground forces (Headquarters Department of the Army, 2006).

Progression of Army Armed Reconnaissance Operations

The OH-58 Kiowa was borne out of the Vietnam conflict as a light observation helicopter designed for observation and artillery scouting. However, over time, the Kiowa progressed from simply a reconnaissance platform to a lethal and adept OH-58D Kiowa Warrior scout-attack helicopter.

The primary mission of the OH-58D Kiowa Warrior is to provide ground troops with overhead aerial gunnery, and fulfills the armed-reconnaissance role for attack helicopter and air cavalry units. The airframe was modified, from its original version, to reduce heat signatures from the engines exhaust through dispersing engine exhaust through its rotor wash. Furthermore, it was implemented with a four bladed composite rotor system and a more powerful engine to give it greater speed and weapons carrying potential (Headquarters Department of the Army, 2005).

Instead of being a platform in which pilots depended on their eyes, aerial perspective and radios alone; the aircraft was fitted with a mast-mounted-site comprised of a laser range-finder/designator and a day/night infrared camera synchronized with a computerized navigation system in order to enhance scout pilot's capabilities to seek, track and engage the enemy. The Kiowa can laser designate targets for its own Hellfire missiles or laser-guided munitions from other aerial platform and ground based weapons systems. In addition to Hellfire missiles, the OH-58D can be armed with air-to-air missiles, Hydra rockets and a .50 caliber machine gun (Headquarters Department of the Army, 2005).

Although the OH-58D Kiowa Warrior was almost replaced with RAH-66 Comanche and the Armed Reconnaissance Helicopter (ARH), it still remains flying to this day, which is a testament to how capable an airframe it has been over the last 30 years it's been in service. The Army plans to keep the OH-58D in service indefinitely while supplementing it with UAS until an all UAS fleet eventually replaces the Kiowa Warrior (Headquarters Department of the Army, 2005).

Visual Perspective from a Helicopter

An OH-58D Kiowa Warrior or an AH-64 Apache provides an insightful perspective of the battle space that is paralleled by no other platforms. The ability of a helicopter pilot to see all around the battlefield from a personally involved vantage point makes his or her presence invaluable to intelligence officers and commanders. In particular, the OH-58D's view is unmatched when its doors are removed allowing the pilots to extend their viewing abilities outside of the aircraft while in flight. The OH-58D is capable of flying just a couple of feet above the surface of the ground or structures and can maintain an eye level perspective of objectives and troops on the ground. Kiowa pilots are not only able to provide invaluable aerial gunnery but their ability to fly low to the ground and see all around is crucial for surveillance. UAS provide a top down perspective, whereas helicopters can provide a horizontal perspective on targets of interest (Martin, personal communication, August 11, 2010).

Current UAS optical technology allows for a near real time perpetual stare over the battlefield. However, UAS views are limited to a broad, a wide-angle observation or a narrow zoom on a particular objective. On the other hand, helicopter pilots are able to be mentally and visually aware of a greater area of the battlefield at all times from a perspective that's from within the fight. The limitation of a helicopter is its time on station being that crews are restricted by their physical ability to continue flying and the amount of fuel that they have onboard. Conversely, UAS can stay aloft for a prolonged period of time. It is up to the intelligence officer and the commander to determine the value of either the focused and involved perspective of helicopters pilots, limited by time and physical restrictions; versus the broad, yet continuous perpetual stare of UAS limited to broad views or fixated zooms (Martin, personal communication, August 11, 2010).

An Army helicopter pilot's heightened sense of surroundings is only sharpened by the fact that their involvement on the battlefield puts them directly in harm's way. Soldiers who have been under fire have referred to scout and attack helicopter pilots, who have come to their rescue, as guardian angels. The moral obligation that helicopter pilots share with their brother's in arms while involved in the fight only increases their alertness and vigilance. Aviators argue that the fifth sense that scout pilots provide is fueled with an adrenaline-filled awareness that

UAS operators will never experience from the relative comfort of their operating stations (Martin, personal communication, August 11, 2010).

Army Fixed-Wing Fleet

Under the Johnson-McConnell Agreement of 1966, the U.S. Army Chief of Staff General Harold K. Johnson and U.S. Air Force Chief of Staff General John P. McConnell, on April 6, 1966, agreed that the Army would give up its fixed wing tactical airlift aircraft, while the Air Force relinquished its claim to most forms of rotary wing aircraft (Bowers, 1983). The agreement was not historically well received by either service. Because of this, Army Officers felt that the Army had lost a valuable capability and the Air Force now took on the responsibility of providing those capabilities for the Army. Over time, this agreement allowed for the Army to continue a small fixed wing fleet in order to carry out essential missions. Although the majority of the Army's aviation inventories are helicopters, the Army currently possesses a fleet of intelligence gathering and transport fixed wing aircraft (Headquarters Department of the Army, 2005).

Army Aviation Guardrail Common Sensor

The RC-12 Guardrail Common Sensor is a pressurized, low wing, all metal aircraft powered by two PT6A-41 turboprop engines and has all weather, day and night capabilities. Piloted by two aviators, it can fly between 20,000 feet to 30,000 feet, with a cruise airspeed of 160 knots and five hours on station. This airplane is designed to collect and target signal intelligence (SIGINT) and relay the information, for real-time analysis, to a digitally tethered ground station. Because this aircraft is "tethered" to the trancieving proximity of its parent ground station for disseminating its intelligence, it is not capable of deploying anywhere in the world unless the entire ground station is moved with it. Although this movement would not be impossible, it would be a logistical challenge (Headquarters Department of the Army, 2006).

The RC-12 provides near real-time SIGINT and targeting information to commanders throughout the corps area. Although the RC-12 Guardrail does not carry any weapons of its own, it gathers selected low, mid and high band radio emissions; identifying, classifying and triangulating the emitters to a targetable location with deadly accuracy for U.S. weapon systems (Headquarters Department of the Army, 2006).

Army Aviation Airborne Reconnaissance Low

The RC-7 Airborne Reconnaissance Low (ARL) is a modified de Havilland of Canada (DHC) fixed wing airplane. Initially, it was classified as a “low profile” intelligence gathering aircraft being that it is painted like a civilian aircraft and could fly in and out of any airport relatively unnoticed by unsuspecting onlookers. Depending on the mission, the flight altitude can vary from 6,000 feet to 25,000 feet for durations of 8-10 hours, piloted by two aviators and serving a crew of up to 5 mission operators. It is an all-metal, high wing monoplane aircraft, powered by four Pratt & Whitney PT6A-50 turboprop engines. The ARL can fly for ranges up to 1,400 nautical miles at a cruise airspeed of 220 knots and a loitering airspeed of 110 knots. The RC-7 is capable of taking off fully loaded under high altitude and hot conditions from an improved or unimproved runway. Furthermore, it can operate at a maximum altitude of 20,400 feet MSL without supplemental oxygen for crew use and 25,000 feet MSL with the crew breathing supplemental air (Headquarters Department of the Army, 2006).

The RC-7 is an intelligence reconnaissance airplane capable of providing tactical commanders with near real-time airborne Communications Intelligence (COMINT), Imagery Intelligence (IMINT) collection and area surveillance in day, night and all weather conditions.

Depending on the mission, the payload on the ARL includes Moving Target Indicator/Synthetic Aperture Radar (MTI/SAR), Forward-Looking Infrared (FLIR), Infrared line scanner (IRLS), a Daylight Imagery System (DIS) and communications intelligence sensors. The ARL is self-deployable and self-sustaining for up to 10 days, capable of operating out of any location in the world. It can provide an immediate down link to commanders and warfighters once airborne. It is designed to provide direct support to wartime operations, and peacetime operations such as counternarcotics and counterinsurgency operations (Headquarters Department of the Army, 2006).

Army Intelligence Fixed-Wing Aircraft Assessment

Both the RC-12 Guardrail and the RC-7 ARL are invaluable assets for commanders and intelligence officers. The RC-12 is renowned for being able to acquire weapon system emitters and radio transmissions from great distances with pinpoint accuracy for lethal target handovers. Although capable of daytime operations, the RC-7 is primarily utilized as the "eyes of the night" for the U.S. Army, allowing commanders and intelligence officers to track the enemy in all weather environments, day or night and monitor movements of small units through battalion-sized elements.

However, both aircraft have limitations. The RC-12 is limited to the digitally tethered range of its data-link with its parent ground station to which it's broadcasting SIGINT and target location data to. Both aircraft are logistically reliant airframes that need perpetual maintenance attention due to their aging airframes.

The missions of the RC-12 and the RC-7 are prime candidates for being replaced by unmanned aerial systems. Prior to the latest advances in airborne technologies, one of the primary reasons that manned airplanes were required for intelligence was because of their size and ability to carry greater payloads. Now, with the onslaught of smaller and lighter sensors combined with the acquisition of larger and more powerful UAS, the requirement for manned aircraft is diminishing. If human pilots are removed from ISR missions, the risk of the loss of lives is also further reduced. Unmanned aerial systems are capable of operating in environments that human pilots can't. Aside from relieving the risk of flight from man, UAS are unfettered in nuclear, biological and chemical environments and able to provide continuous collection and targeting in an uninhabitable atmosphere. Furthermore, both the RC-12 and the RC-7 are limited in endurance. On the other hand the Army's ERMP, for example, is capable of flying for over 24 hours straight, depending on its payload and altitude. It would seem rational for the Army to replace its fixed-wing intelligence airplane missions with UAS due to the emerging technologies, their ability to fly in hostile environments and long endurance times.

Dangers and Risks of Manned Flight

Aside from the obvious benefits of having manned aircraft on the battlefield, there are also significant dangers and risks posed to manned aircraft. The most apparent is that reconnaissance and attack helicopter pilots must be exposed to enemy threats in order to find and fix the enemy. Although fixed-wing intelligence aircraft fly at higher altitudes they are still at risk by far-reaching surface to air missiles and man pads. Even fixed-wing aircraft are threatened from small arms fire during takeoff and landing. It is arguable that despite the advantage of having the human element from an aerial perspective, it's better to lose a UAS than an expensive helicopter, airplane or a priceless crew.

To err is human; and people, by nature, will inevitably make errors during flight. According to research performed by the FAA for Human Error Analysis of Commercial Aviation Accidents and Classification System (HFACS), 70% to 80% of all aviation accidents are caused by human error (HFACS, 2000). Pilots work in complex environments, with state of the art equipment, where precision is required in order to maintain safe operations within a narrow margin of error. In multi-crew operations, Crew Resource Management (CRM) is imperative for the control of aviation technology as a team. The majority of aircraft accidents statistically take place during takeoff and landing (HFACS, 2000). These human errors can be rooted in physiological and psychological limitations, such as fatigue, workload, fear, cognitive overload and stress to mention a few. CRM helps to alleviate and overcome human error; however, even the best-trained pilots and crews are susceptible to being human.

Remove the human factor from flight, and perhaps the 70-80% of all aviation accidents could be greatly reduced, if not alleviated. The concept of flying a UAS removes the human error out of aviation accidents. Yes, UAS operators are “piloting” the aircraft; but they are greatly aided by a computerized system that actually flies the aircraft based on the operator’s inputs via a computerized graphic interface. Today’s UAS operators have been taught to pilot their unmanned systems through a computerized interface system referred to as “point and click flying.” Being that the majority of manned accidents are caused by human error, the utilization of UAS technology could greatly benefit military operations. The implementation of UAS not only removes the risk to people in combat operations but also removes the risk of human error to aircraft and the potential for accidents.

Brief History of Unmanned Flight

The origins of UAS for military use began in 1915, when Tesla alleged that an armed, pilotless-aircraft could be used to defend the United States of America. In 1919, Elmer Sperry, the father of the gyrocopter and the autopilot, used a non-piloted aircraft to sink a captured German battleship as part of a display of this technology (Executive Summary, 2010). More specifically, the concepts of UAS within the sphere of reconnaissance and attack operations are not new to the United States military. During the American Civil War, both Union and Confederate forces utilized unmanned hot air balloons armed with explosives in hopes of destroying enemy weapons caches and disrupting command and control during combat. Furthermore, both Confederate and Union Armies utilized hot air balloons with cameras in order to capture pictures of the battlefield from an aerial perspective. Over time, the concepts of unmanned aerial systems evolved into highly technologically advanced instruments that have become critical tools for commanders to utilize for reconnaissance and attack operations (Headquarters Department of the Army, 2006).

Fort Huachuca has always been the proving grounds for Army UAS technologies. As far back as 1953, the Army was secretly testing UAS at the now famous Black Tower. In 1979, the Army started its first major UAS acquisition effort with the Aquila program. During operational testing in 1987, the Aquila program successfully met mission requirements in only seven of 105 flights. However, in 1985, the Department of Defense procured the Pioneer as its first operational UAS system, which in 1991 flew over 300 combat missions during Operation Desert Shield/Storm hunting for Scud missiles and high value targets for coalition commanders. Today, the Unmanned Aircraft Systems Training Battalion conducts all UAS training, which includes the Shadow, Hunter and ERMP at Fort Huachuca (Headquarters Department of the Army, 2006).

In the beginning of OIF and OEF, the U.S. Army only had 45 UAS in its inventory. Now armed with over 4,000 unmanned aerial systems and growing, Army UAS are now making national headlines as they assume missions and responsibilities that have traditionally been reserved for manned aircraft. The Army intends to capitalize on allowing UAS capabilities to reduce human workload and risk, thus improving agility, flexibility and adaptability while reducing human risk (Headquarters Department of the Army, 2006).

UAS Mission Packages

Mission packages are equipment carried on a UAS configured to accomplish a specific mission. Typical payloads include sensors, communications relays, weapons and cargo (internal or external). Technological advances have greatly increased payload performance. Typical mission packages include:

Table 3

Typical UAS Mission Packages

Sensor payloads including electro-optical cameras, infrared, synthetic aperture radar (SAR), signal intelligence (SIGINT) and electronic jamming and attack systems.
Communications payloads extend voice and data transmissions through the UAS. This abilities includes retransmission and communications relay.
Weapons payloads including both lethal (missiles and bombs) and non-lethal systems are designed to injure, kill or incapacitate people; damage or destroy property; or otherwise
Cargo capabilities allow a UAS to deliver and or pickup supplies, equipment or possibly personnel involved in Special Operations operating well beyond friend lines.

Note. Data provided by Senior UAS Instructors, UASTB, Fort Huachuca, AZ

Remotely Piloted UAS Definition

A remotely piloted UAS is comprised of the unmanned aircraft, payload, control element, weapons payload, display, communication architecture, and includes the supporting soldiers. Anything but “unmanned,” the remotely piloted UAS tactical and operational employment absolutely requires the “human element.”

Autonomously Piloted UAS Definition

Autonomously piloted UAS fly and perform mission profiles under the control of a computer program. With autonomous unmanned aerial systems, specialists program an onboard computer that controls the aircraft flight from point to point. The UAS may take off and land itself. While humans oversee the programming and tell the UAS where to go, it's actually the onboard computer that controls the UAS in flight. Although not unheard of, the Army is focusing its acquisition on remotely operated unmanned aerial systems.

Primary Army Unmanned Aerial Systems

The RQ-11 Raven B is a hand held, portable, day/night; remotely operated system used in small units such as Infantry and Special Operations units. The Raven is so simple to operate, that anyone can program, launch, fly, retrieve and maintain it. This small UAS conducts surveillance during routine screening operations for small units in order to see beyond their line of sight past visual obstacles (Headquarters Department of the Army, 2010).

The RQ-7B Shadow has been the mainstay of Army unmanned aerial system operations and was the catalyst for the windfall of UAS technologies sought after by the Army. It is a lightweight, transportable, tactical system capable of utilizing a number of different sensor packages, making it one of the most productive and widely used reconnaissance systems in military history. Examples of the systems it can carry are: communications relays, laser designator/rangefinder, and multiple optic sensors (Headquarters Department of the Army, 2010).

The MQ-5 B Hunter was designed to extend the platform endurance of UAS from the RQ-7B's from 5 hours to 20 hours. Furthermore, being that it's a larger aircraft, it was able to carry heavier, yet improved, sensors such as multi-mission optronic stabilized cameras, laser designator/rangefinder, target illuminator, communications relay packages and capable of carrying Viper strike guided bombs (Headquarters Department of the Army, 2010).

The MQ-1C Extended Range Multi-Purpose (ERMP), based on the Air Force Predator, was intended to replace the Hunter. With an 800 pound payload, the ERMP can carry everything that the Hunter UAS carries, utilizes synthetic aperture radar and can be armed with Hellfire missiles Viper strike guided bombs or Stinger missiles (Headquarters Department of the Army, 2010).

Human Causal Factors and Unmanned Aerial System Operations

Even though unmanned aerial systems have provided great results while significantly reducing risks to human pilots, they are still capable of accidents. Although UAS offer advantages, they do have disadvantages. Remotely piloted UAS require a complex and highly reliable communication link to the control station. While automating some functions within a UAS control system may overcome certain remote operational disadvantages, pilots argue that removing the man from the cockpit (e.g. piloting a UAS remotely from a great distance away and relying on a computer interface for cognizance of the battlefield) reduces the ability to make rapid decisions with maximum situational awareness (SA). Generally speaking, “computers are best at calculations and humans are best at decision-making” (Hancock & Scallen, from Noyes & Bransby, 2001, Figure 7.1).

Chief Warrant Officer Mark Martin, who served as an Army Aviation Safety Officer for over 25 years, was selected to work with the research and development of the RAH-66 Comanche Program and assisted in studies in coupling manned and unmanned systems. He discovered, through tests conducted with UAS and manned aircraft coupling, that pilots remotely controlling UAS through digital displays, were slower to develop the situation and had a harder time maintaining SA; whereas, it came instinctively to a pilot in a manned aircraft, particularly in Army close combat attack and TIC immediate support roles. His studies concluded that there is nothing that can replace actually being on the battlefield, seeing and smelling the battle, taking in human interactive, real-time information not filtered electronically through technology (Martin, personal communication, August 11, 2010).

He further explained that another consideration is dissociative phenomenon or the tendency for UAS operators to lose real-time, immediate association with the battlefield. This is due to the differences in human perception between physical experiences sensation and electronically enhanced viewing. In order for UAS pilots to maintain a similar level of situational awareness, the technology must be intuitive, responsive and almost seamless in order to allow the operator to interface the UAS without perception barriers. Martin suggested that perhaps head mounted 360-degree technologies with integrated aural, tactile and visual pathways as well as tactile feedback and response systems could significantly enhance a UAS operator's ability to better "experience" the battlefield environment and increase the operator's comfort levels and SA. For example, systems that are mounted or worn directly on the body, such as the night vision goggles (NVG) that Army helicopter pilots wear, are easier for the operator to interface with on a more subconscious level than those that aren't, such as computer or cockpit displays, which what UAS operators are currently utilizing (Martin, personal communication, August 11, 2010).

Pilots have an on-the-spot awareness of their surroundings, such as weather information, that a UAS operator may not have while remotely piloting the UAS. For example, according to an RQ-1 Predator accident report released by Langley Air Force Base in 1999, a Predator crashed in Bosnia after experiencing icing, while simultaneously experiencing a fuel leak. The weather information that was being provided to the UAS operators did not indicate icing conditions. The UAS pilots attempted to perform recovery procedures but were unable to land the UAS safely. According to the accident report, the pilot's attention became fixated on the severe weather conditions and they lost control of the UAS and were unable to recover aircraft (U.S. Air Force, 1999). A manned pilot would most likely have been able to better assess react to a similar situation. Most likely, a manned pilot could have avoided the situation altogether.

One of the greatest advantages of utilizing pilots is the human element on the battlefield for attack operations by literally having eyes on the target and their instantaneous awareness of the conditions around them while they're directly involved in the fight. As Chief Warrant Officer Martin explained, the pilot's ability of seeing and smelling the battle, taking in human interactive real-time information and processing it instantly and naturally is a serious issue that should be taken into consideration by Army planners (Martin, personal communication, August 11, 2010). Conversely, the SA that UAS operators possess has to be gleaned through digitally processed information. Moreover, to further enhance the pilot's natural senses, aircraft are equipped with low-light television with zoom, focus and tracking capabilities; FLIR and direct-view optics, and a variety of weather warning systems and traffic collision avoidance systems that allow human pilots to increase their situational awareness in order to navigate through adverse weather conditions, both day and night.

Moral Considerations over UAS Operations

A civilian interviewed for this research stated, "I worry that the distance will make it easier to forget that real humans on the other side are getting hurt and killed" (Pool, personal communication, September 14, 2010). Her worries revolve around the fact that removing pilots from the battlefield and solely replacing them with UAS may negate the human understanding;

compassion and empathy that manned inevitably bring to a combat zone. Yes, combat aviators are deployed in order to find and fix the enemy; however, pilots who are themselves fathers, sons and brothers can empathize with the human beings that are ensnarled in the fog of war. Recent engagements have brought criticism to the U.S. military due to residual outcome of civilian casualties that have fallen victim to UAS attack operations. It is arguable that manned pilots could have prevented these situations. However, at what costs to the pilots? Commanders and intelligence officers need to weigh the value of removing military pilots from harm's way versus the potential of putting civilians into harm's way through the inevitable disconnect caused by the inherent distance of UAS operations.

Summary

The Army is beginning to view unmanned aerial systems as combat multipliers because of their ability to increase the SA of commanders and intelligence officers, reduce the workloads of aircrews and minimize risk of human life. In spite of this, nothing has yet replaced the ability of pilots who can immediately process information on the battlefield and act on it accordingly. In particular, a helicopter pilot's senses and instincts are directly involved with what is happening on the battlefield. Whereas, comparatively speaking, a UAS operator has a disconnected and remote perspective of the battlefield. Over time, the Army will begin to acquire unmanned aerial systems that will begin to measure up to the senses of actual pilots. During this period of rapid technological advancement, it will be of keen interest to commanders and intelligence officers as to what is actually more valuable: the value of intelligence and attack capabilities of manned aircraft or the intelligence and attack capabilities of unmanned aircraft.

Statement of the Research Question

All efforts of this research have concentrated on answering the following question: can the current and forecasted capabilities of Army UAS surpass the value of reconnaissance and attack capabilities of manned pilots. Supporting questions are:

- Do current UAS technologies allow Army commanders and intelligence officers the same quality of reconnaissance as manned aircraft assets?
- Is the SA obtained from UAS comparable to Army aviators who are directly involved in the fight?
- Can attack operations be carried out with the same desired end state with unmanned aerial systems as can be carried out with manned aircraft?
- Does the remote, distant ability of UAS provide a safer alternative to an equal product or a degraded product with the benefit of protecting human lives?

CHAPTER III

RESEARCH METHODOLOGY

Research Model

A survey utilizing quantitative methods was used to concentrate on the identified research questions for this paper. The survey sample was further sub-divided into smaller groups of Army aviators, commanders, intelligence officers and civilians in order to establish the attitudes and opinions of the different populations.

Survey Population

The researcher assessed the attitudes and opinions of aviators, commanders, intelligence officers and civilians who are involved with both manned and unmanned Army aviation operations. The commanders selected for interview had previous experience in either Operation Iraqi Freedom and or Operation Enduring Freedom. The intelligence officers and civilians were held to the same criteria. All aviators, both pilots and UAS operators have had experience during combat operations.

Sources of Data

Questions were administered through a data collection device in the form of an online survey and questionnaire in order to obtain information. Quantitative data was acquired through the use of a developed questionnaire oriented to providing solutions to the identified research questions.

The Data Collection Device

The data collection device consisted of a questionnaire via an online survey. It contained demographic information such as rank and military experience and focused on the experience of the respondents with both UAS and manned flight operations. Furthermore, it focused on questions that identified the attitudes of aviators, commanders, intelligence officers and civilians towards this topic.

Pilot Survey

Seven Army aviators and UAS operators were selected to partake in the pilot testing of the questionnaire and the survey prior to distribution. This initial pilot testing made certain that the questionnaire and the survey are clear and to the point and that they meet the needs of answering the identified research questions for the intent of providing actionable data for this research. Aside from partaking in this pilot study, the seven aviators, commanders, intelligence officers and civilians selected were also given an opportunity to provide feedback and share their insights regarding the survey and questionnaire with the researcher.

Instrument Pretest

A pretest was not administered for this survey and questionnaire. Rather, the demographic information provided in the survey was used to screen respondent's eligibility. Responses from individuals that were qualified as aviators, commanders, intelligence officers and civilians were included in this study; however, responses from unqualified individuals were screened and therefore discarded.

Distribution Method

The survey and the question were distributed through email and accessible via the Internet. However, paper copies were made available to individuals who requested them either in person or via the postal system. Additionally, the researcher utilized a combination of mail, telephone, email and personal visits in an attempt to foster support and assistance from aviators, commanders, intelligence officers and civilians. Through utilizing various methods of contacting potential candidates, the researcher sought to identify a portion of the population that will successfully reflect a majority of thoughts and attitudes on the research topic.

Instrument Reliability

Z-tests were utilized in order to determine the value of respondents' views about UAS verses manned aerial assets. These scores were then computed in order to establish accuracy of the data. Furthermore, the validity of the survey was attained through feedback following the pilot study based on the Army Aviators replies.

Procedures

The survey results were tallied and organized into a spreadsheet for statistical analysis. First, the demographic data was analyzed to determine the variation in participants in order to include the more specific sub-groups of aviators, commanders, intelligence officers and civilians. Then the answers were grouped according to their associated premise and scrutinized for reliability and consistency. Any inaccurate, incomplete or misleading survey information was discarded.

Assumptions

It is assumed that the data collection device is objective and able to encapsulate accurate answers. It is also assumed that there were not biased answers amongst the populations being surveyed and that the individuals being surveyed were as accurate and honest as possible.

Limitations

Accessibility to a large population that was willing to participate in the survey and questions related to this research was a challenge. Often military commanders, intelligence officers and pilots were deployed and therefore unable to participate in this research.

Treatment of the Data

This data was run through various statistical tests in order to determine the significance of the answers. Once the surveys and questionnaires were returned, the data was compiled, analyzed and organized into charts and tables presented in later chapters.

CHAPTER IV

RESULTS

The survey was disseminated through email and accessible through the Internet via an exclusive website. Furthermore, printed surveys were available to individuals who requested them either in person or via the postal system. The data was assembled through a combination of mail, telephone, email and personal visits. This paper summarizes the opinions, understandings and viewpoints of aviators, commanders and intelligence officers who have had experience either with UAS technology, aviation operations or both.

The information is presented both through a combination of qualitative and quantitative methods. Because the data of this topic was an amalgamation of the personal attitudes of the military leaders interviewed, the report is heavily qualitative in its effort to bring their views and experiences together into one status quo. The focus of this paper is first on the phenomena that has transpired through the evolution of the Army's aviation branch and the effects of the recent rapid application of UAS; secondly, it concentrates on the phenomena of the reactions of the users and attempts to gather the complexity of their opinions into this report. This topic has many dimensions and layers of mindsets through the attitudes and ideas presented. It is important to gauge the opinions of these military leaders, because they are the impetus of change that will continue to generate transformation into the future and will mold the forthcoming courses of action for the Army and how our nation will fight wars. This paper incorporates interpersonal experiences, creative thought processes, personal opinions and lessons learned; in order to make sense of the social phenomena brought about by this rapid technological advancement. Consequently, the conclusions of the military leaders interviewed are often best portrayed through a qualitative fashion, which is what this research project has sought to do.

There is an over abundance of statistical data, tests and scientific theories to prove the soundness of the implementation of UAS and their impact on the battlefield. However, this paper does not attempt to prove or disprove what has already been proven. Rather, this paper seeks to determine, through the personal experiences of pilots, commanders and intelligence officers, whether the data and research that has already driven the Army to procure UAS technologies is truly in fact what it has been heralded to be and whether it is the right direction for the Army to go. This research, more or less, is a check and balance designed to gauge the reactions and opinions of military leaders on their assessments of replacing the proven concepts of manned aviation tactics with new theories of UAS technologies.

On the following pages, the results of the survey have been presented through charts and figures that provide the data from the research questions posed in research. The objective is to provide simple, quantitative, easy to understand, empirical data, which quickly and precisely captures the positions of military leaders who have had direct involvement with piloted aviation operations and UAS operations.

Do you feel that UAVs provide timely intelligence concerning the enemy, terrain, and weather throughout the AO and early warning against enemy observation or attack better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	35.3%	12
Agree	35.3%	12
Disagree	23.5%	8
Strongly Disagree	5.9%	2
	Why?	30
	answered question	34
	skipped question	1

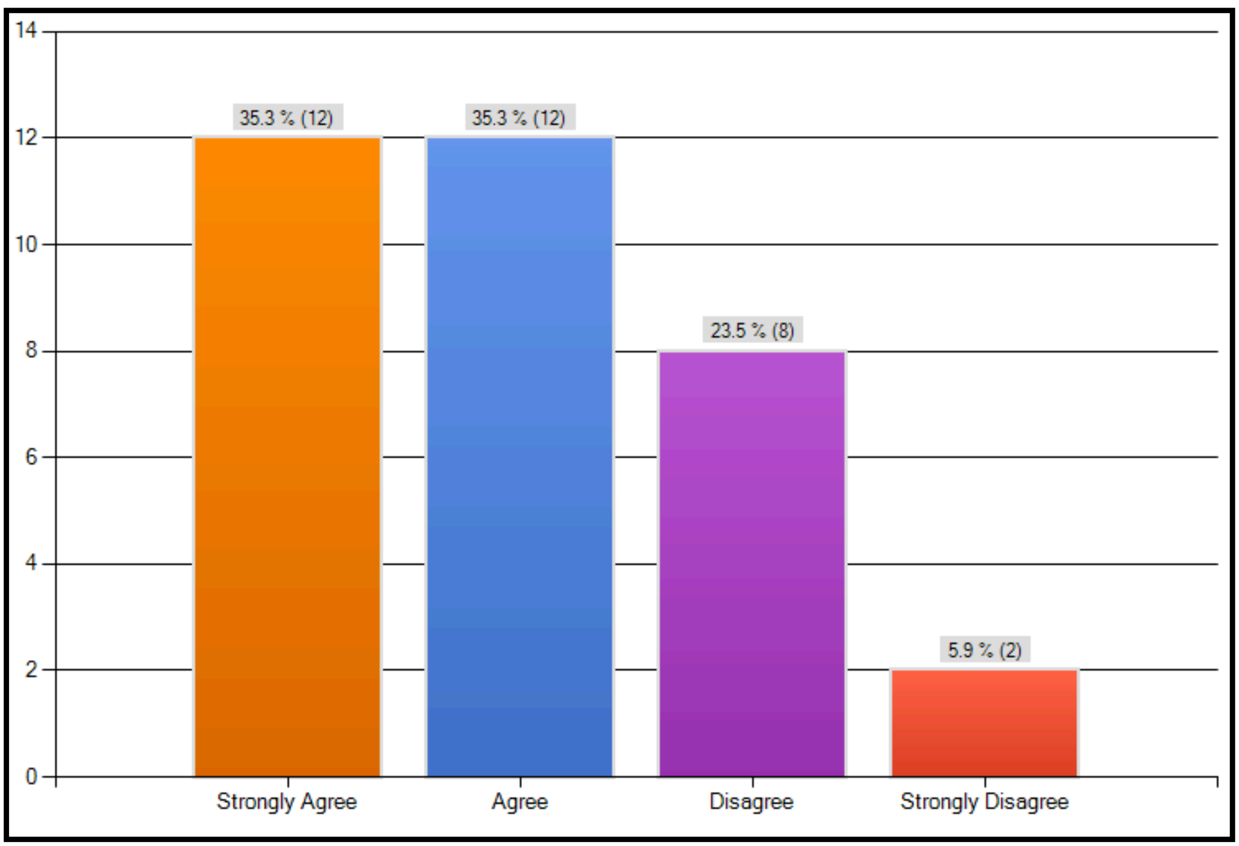


Figure 1. Comparison of timely intelligence between UAS and manned aircraft

Do you believe that UAVs can conduct operations across a wide range (peace, conflict, and war) against threats ranging in size from major regional powers, lesser powers, and terrorist groups to include insurgents better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	40.0%	14
Agree	25.7%	9
Disagree	31.4%	11
Strongly Disagree	2.9%	1
	Why?	29
	answered question	35
	skipped question	0

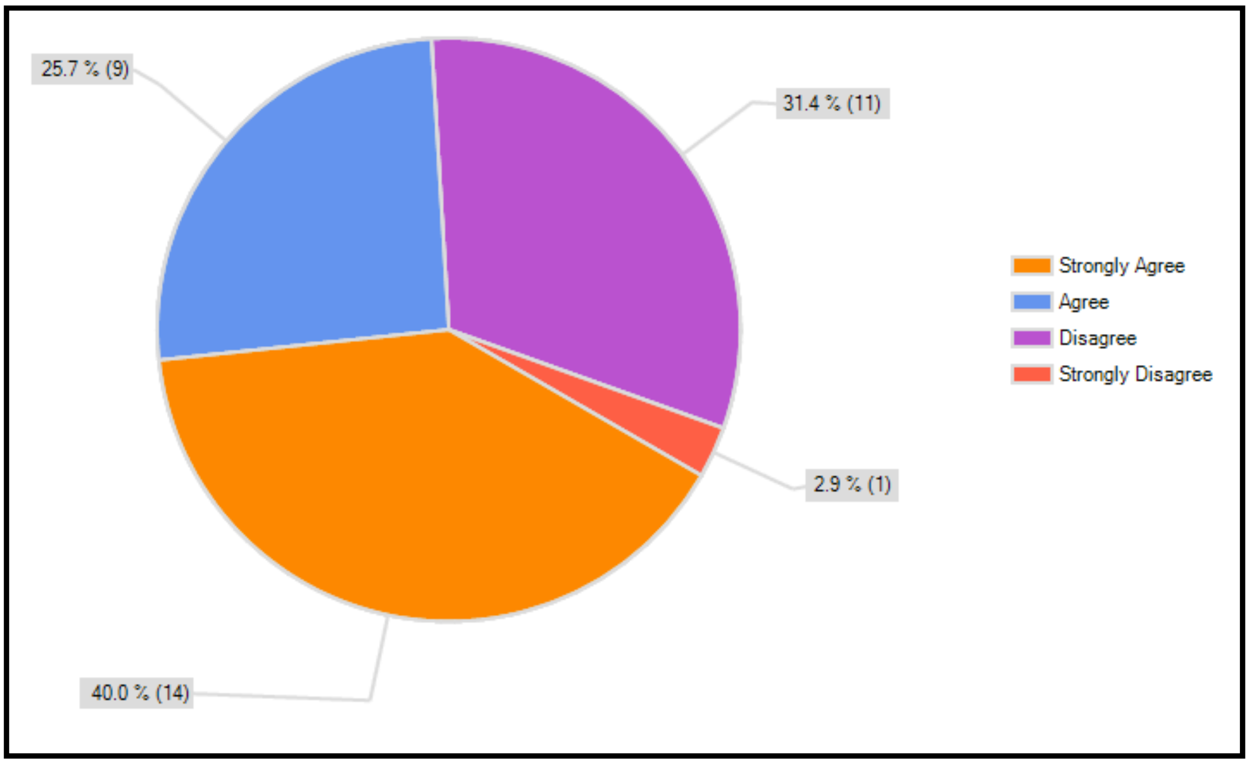


Figure 2. Assessment of multi mission ability between UAS and manned aircraft

Do you believe that UAVs extend the aerial reconnaissance and screening capabilities and supports the economy of force role during offensive, defensive, rear, and retrograde operations better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	37.1%	13
Agree	**40.0%**	**14**
Disagree	22.9%	8
Strongly Disagree	0.0%	0
	Why?	27
	answered question	**35**
	skipped question	**0**

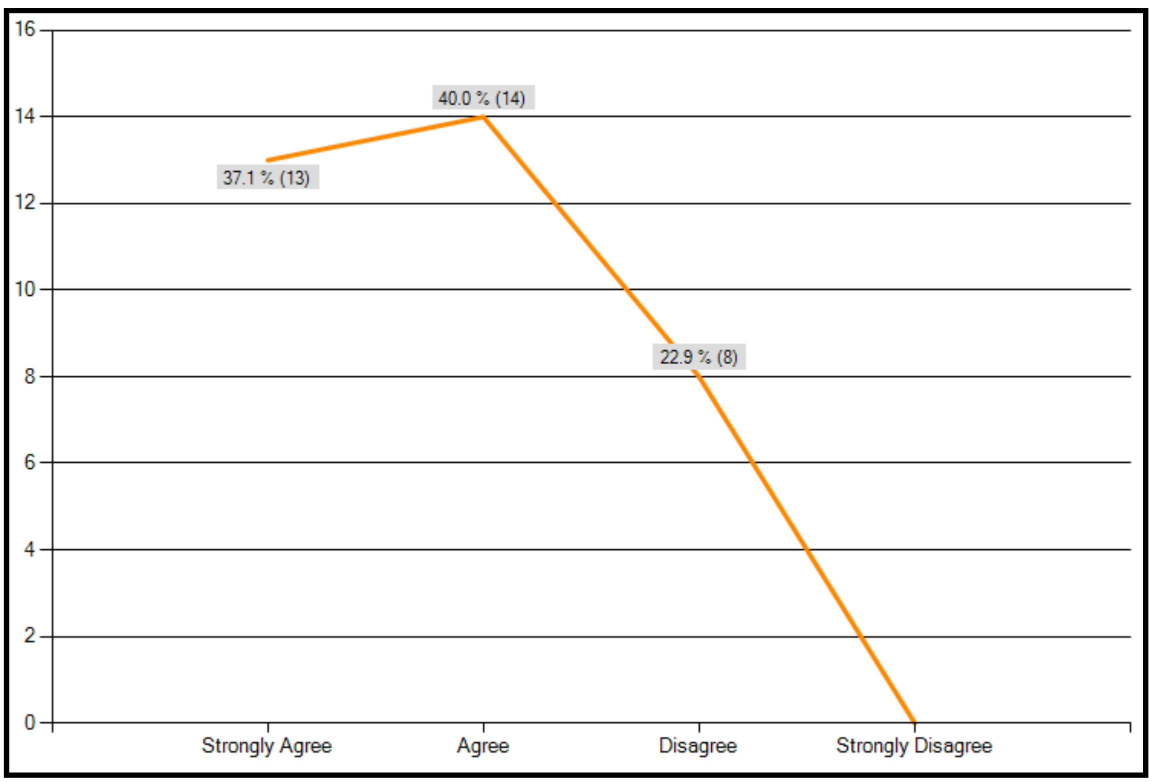


Figure 3. Consideration of support potential between UAS and manned aircraft

Do you believe that UAVs provide timely combat information concerning the enemy, terrain, and weather throughout the AO and early warning against enemy observation or attack enabling intelligence officers and commanders greater C2 on the battlefield better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	37.1%	13
Agree	28.6%	10
Disagree	34.3%	12
Strongly Disagree	0.0%	0
	Why?	27
	answered question	35
	skipped question	0

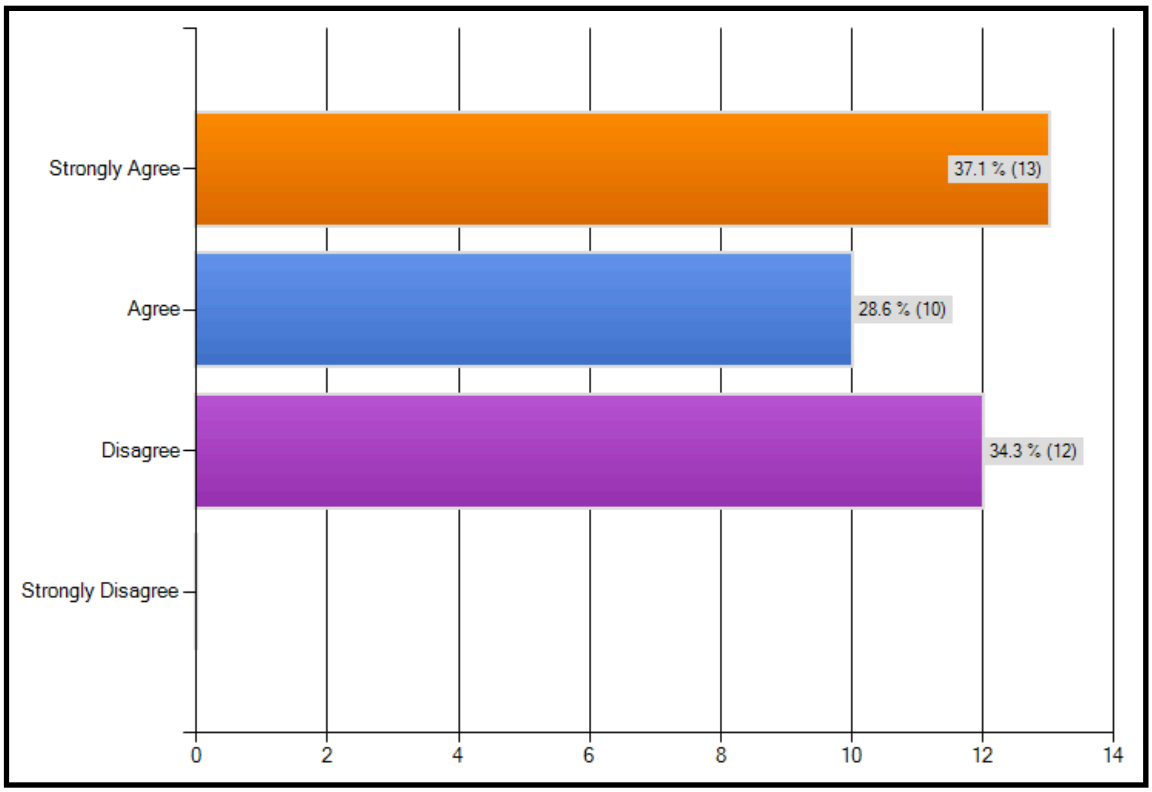


Figure 4. Comparison of timely information between UAS and manned aircraft

Do you feel that UAVs perform C3I enhancement, surveillance, reconnaissance, raids, air assault security, convoy security better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	21.9%	7
Agree	31.3%	10
Disagree	**43.8%**	**14**
Strongly Disagree	3.1%	1
	Why?	27
	answered question	**32**
	skipped question	**3**

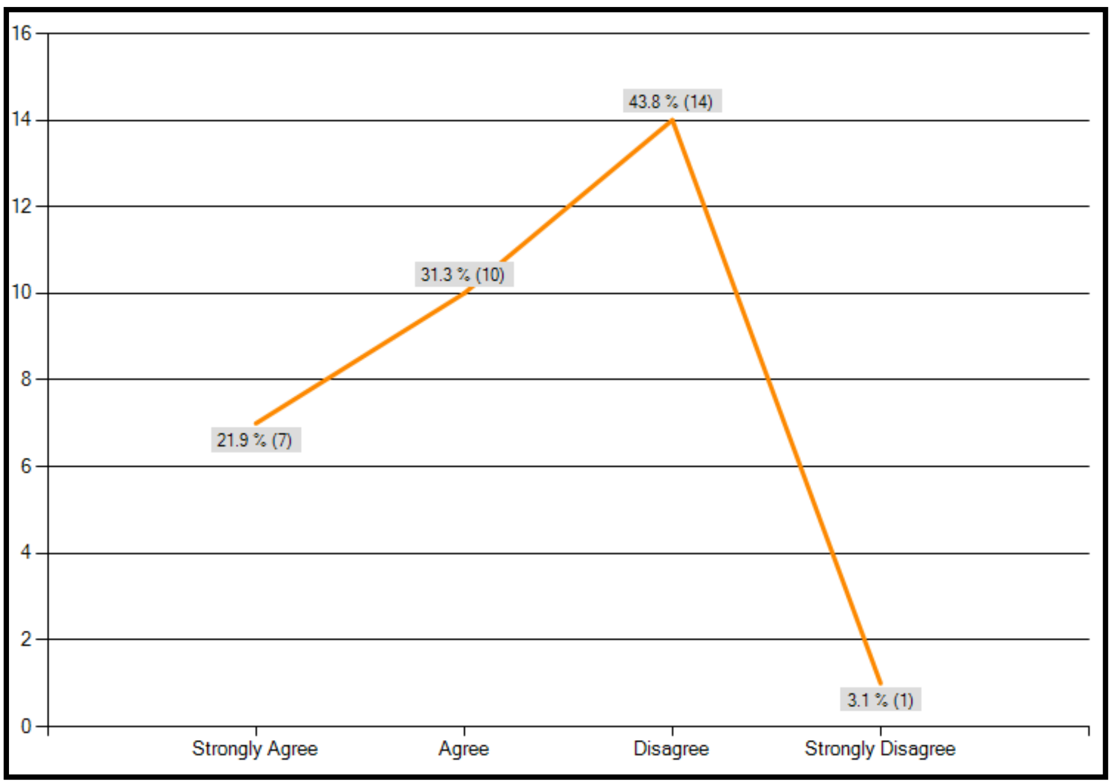


Figure 5. Opinion of security provided between UAS and manned aircraft

Do you believe that UAV operators have an equal situational awareness of the battlefield, as manned pilots, with today's technologies?

	Response Percent	Response Count
Strongly Agree	20.6%	7
Agree	20.6%	7
Disagree	**47.1%**	**16**
Strongly Disagree	11.8%	4
	Why?	28
	answered question	**34**
	skipped question	**1**

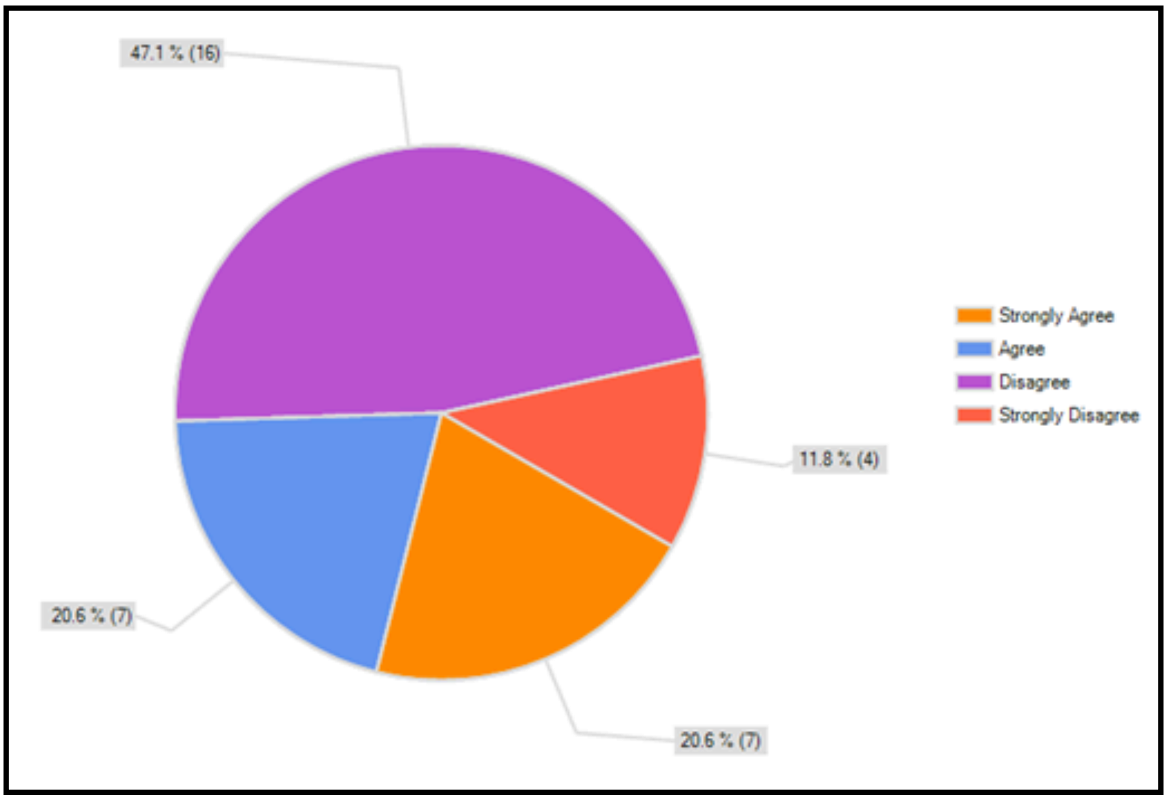


Figure 6. Assessment of SA between UAS and manned aircraft

Do you believe that UAVs can be utilized to attack in depth in order to extend the influence of the force and dominate avenues of approach better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	31.4%	11
Agree	31.4%	11
Disagree	**37.1%**	**13**
Strongly Disagree	0.0%	0
	Why?	26
	answered question	**35**
	skipped question	**0**

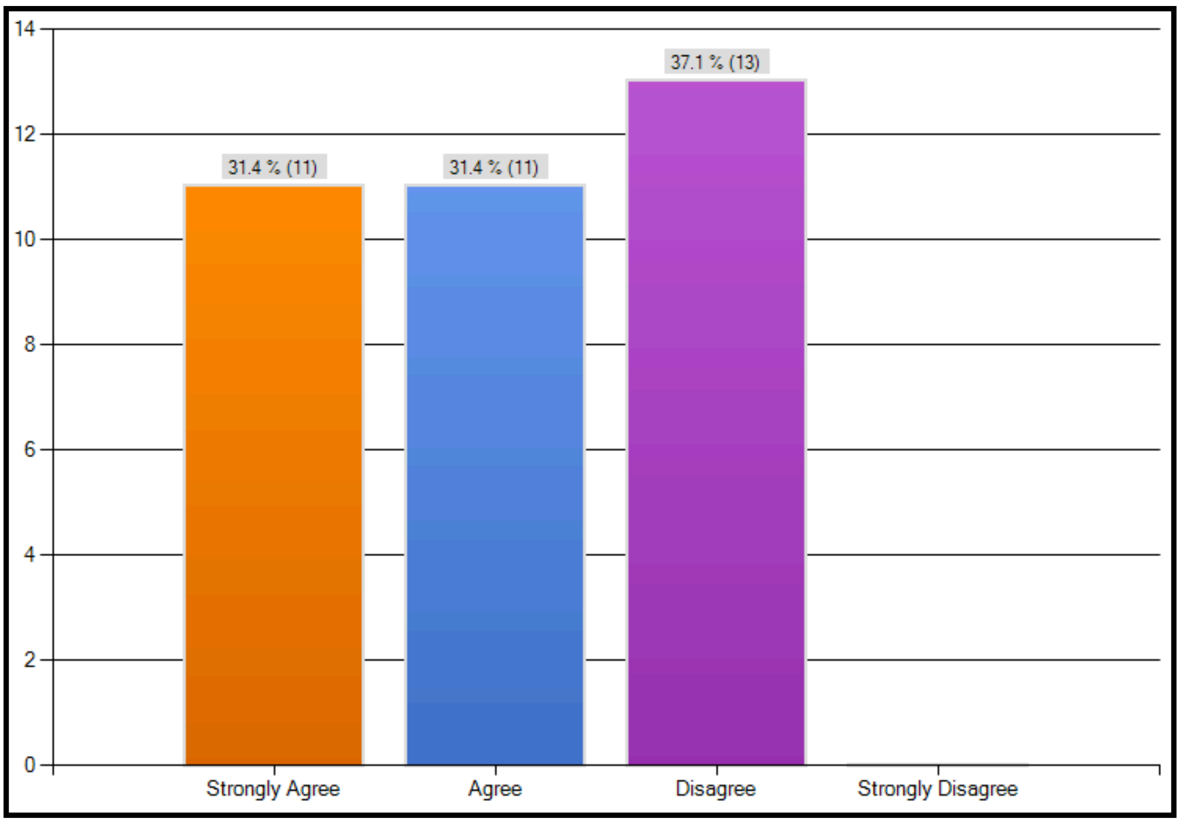


Figure 7. Assessment of attack capabilities between UAS and manned aircraft

Do you believe that UAVs can be utilized to reinforce ground forces by fire, protect the flanks of a moving or halted friendly main body and provide security for the movement and passage of lines by ground forces better than manned aircraft?

	Response Percent	Response Count
Strongly Agree	25.7%	9
Agree	11.4%	4
Disagree	**60.0%**	**21**
Strongly Disagree	2.9%	1
	Why?	27
	answered question	35
	skipped question	0

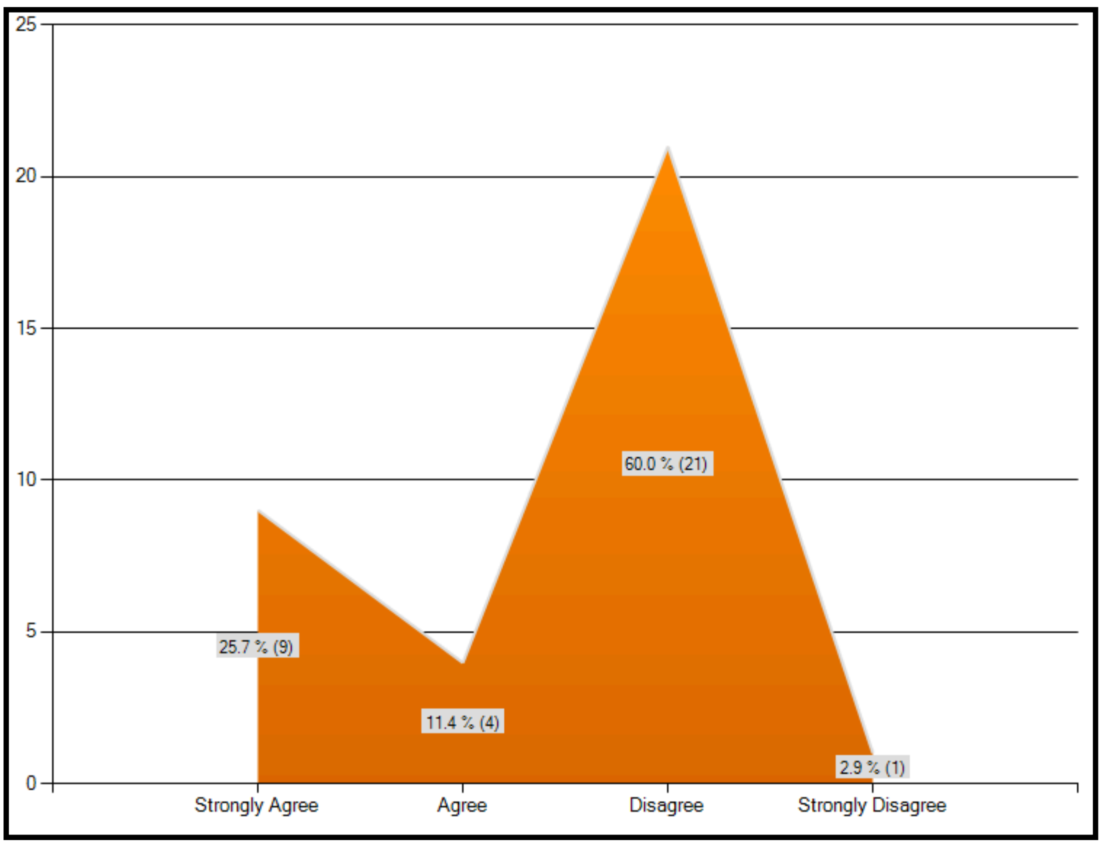


Figure 8. Opinion of support for TIC between UAS and manned aircraft

Do you believe that UAVs are better than manned aircraft for intelligence and attack missions because they are expendable and can be flown into dangerous environments without risk to human life or argument?

	Response Percent	Response Count
Strongly Agree	42.9%	15
Agree	34.3%	12
Disagree	20.0%	7
Strongly Disagree	2.9%	1
	Why?	25
	answered question	35
	skipped question	0

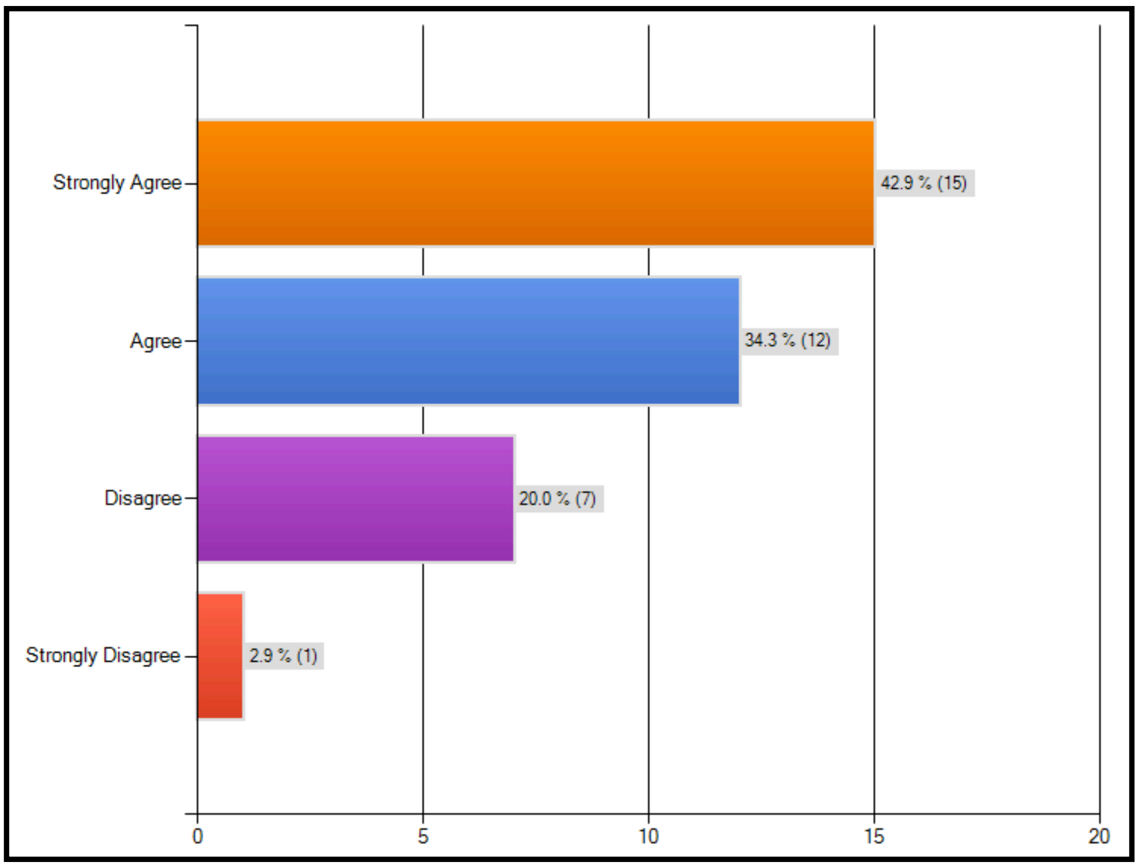


Figure 9. Comparison of expendability between UAS and manned aircraft

Pilots are embedded, albeit from an aerial perspective, in the fight alongside ground troops and their senses and instincts are directly involved with what is happening on the battlefield. Comparatively speaking, UAV operators have a more remote and distant perspective of the battlefield. Do you believe that pilots on the battlefield provide a better solution for reconnaissance and attack operations than UAV operators because of the "human element" (the ability to assess situations, apply logic, make decisions and disagree with orders), which can't be replaced with technology?

	Response Percent	Response Count
Strongly Agree	32.4%	11
Agree	50.0%	17
Disagree	14.7%	5
Strongly Disagree	2.9%	1
	Why?	27
	answered question	34
	skipped question	1

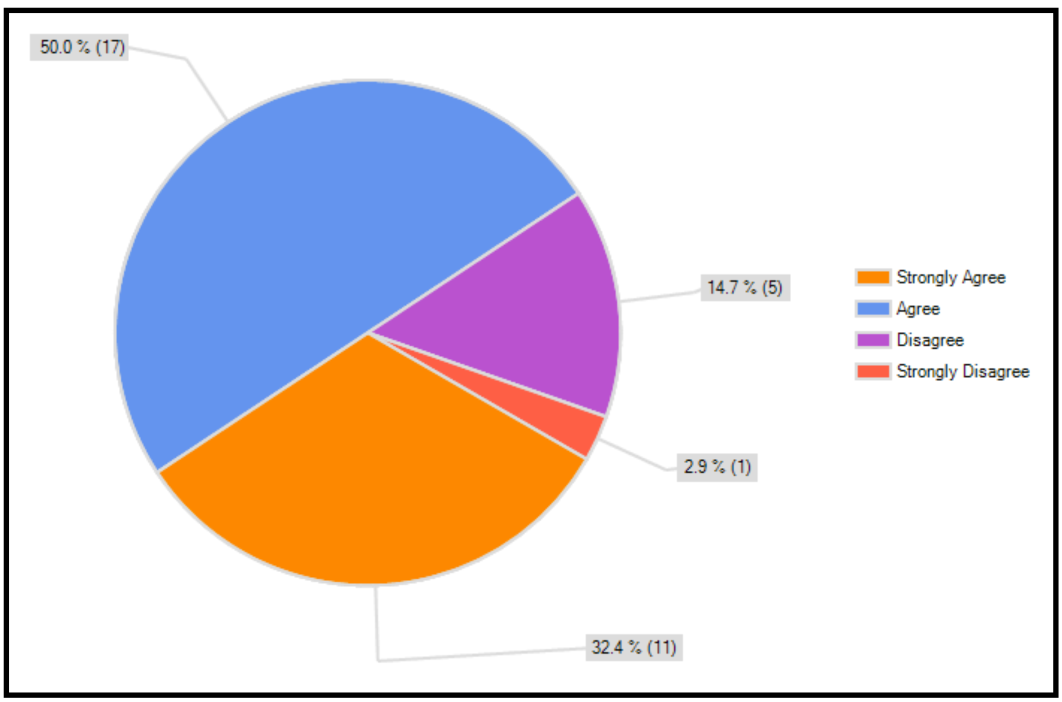


Figure 10. Pilots superior choice due to added human element on the battlefield

CHAPTER V

DISCUSSION

Survey Population

The survey included 34 respondents who were aviators flying either manned or unmanned aircraft, commanders and intelligence officers. Some of the officers who were included in this research served multiple positions such as pilot, commander and intelligence officer. The senior officers questioned in this survey were senior commanders, intelligence officers and pilots. All of the military respondents have deployed to Iraq, Afghanistan or both. The majority of respondents surveyed, who do have experience with UAS, represent officers and senior enlisted soldiers who have been elected to lead, teach or plan within the Army Unmanned Aircraft Systems Training Battalion at Fort Huachuca, Arizona.

Of the respondents, 36.1% were company grade officers who either served as commanders, intelligence officers, battle captains and or pilots. The senior enlisted population, of 27.8%, consisted of UAS operators who were instructors and also worked within the intelligence community. The warrant officers in this survey, 19.4%, were all pilots who have flown missions in Army aviation attack and reconnaissance communities. The field grade officers, 8.3 percent, served as senior officers in command at the battalion or brigade level or who worked as intelligence specialists in their field. Civilians made up 8.3% of this survey, and worked for government intelligence agencies, providing an alternative perspective to the UAS phenomena.

In particular, 16.2% worked as intelligence officers, 51.4% flew as pilots, and 16.2% held the position of unit commanders. The experience with UAS varies throughout the respondents in this survey. UAS pilots surveyed represented 16.2% of the total population. Officers who had experience commanding a UAS unit in either Iraq or Afghanistan made up 5.4% of the population. Of the intelligence officers who utilized UAS technologies, 13.5% responded that they obtained intelligence from UAS regularly while deployed. Although 32.4% of the pilots who were included in this survey did not have experience with UAS, they provide contrast between the perspective of manned and unmanned aviators through their aviation expertise in manned aviation operations. Approximately 18.9% of the respondents had experience flying manned/unmanned missions (MUM) in the theaters of Iraq & Afghanistan.

Contrast of Timely Intelligence between UAS and Manned Aircraft

One only has to keep in mind the limitations of manned aircraft in order to understand the majority of respondents stated they felt UAS were better than manned aircraft in terms of timely intelligence. Flight crews are restricted by their physical ability to continue flying and the aircraft are limited by the amount of fuel they can have onboard with particular payloads. Conversely, UAS can stay aloft for longer periods of time. For example, depending on the payload and altitude flown, the Army's ERMP can stay airborne for over 24 hours. Most manned aircraft can't stay aloft for that amount of time; eventually the pilots will grow fatigued and the aircraft will need fuel. It is up to the intelligence officer and the commander to determine what they need for a given mission. The choice often boils down to choosing between the value of personally involved perspective provided by helicopters pilots; or the broad, long standing perpetual stare of UAS.

Of the respondents, 70.5% of the individuals questioned on this survey agreed that UAS provide timely intelligence concerning the enemy, terrain, and weather throughout the Area of Operations (AO) and early warning against enemy observation or attack better than manned aircraft. Only 29.4% of respondents either disagreed or strongly disagreed to UAS providing more timely information to intelligence officers and commanders. The majority of the individuals questioned on this survey show that there is a common senses that feel UAS provide more timely intelligence of the battlefield.

Assessment of Multi Mission Ability between UAS and Manned Aircraft

UAS are a solution for a platform that can conduct operations across a wide range of operations. UAS allow intelligence officers and commanders the ability to gather information with a lesser chance of being detected and it provides a bird's eye view of the terrain/situation in a wide range of different scenarios.

The majority of respondents, 67.7%, stated that they agree that UAS can conduct operations across a wide range (peace, conflict, and war) against threats ranging in size from major regional powers, lesser powers and terrorist groups to include insurgents better than manned aircraft. Due to their lower startup and operating costs, UAS are much more adaptable to being deployed to a wider range of operational fronts than conventional airborne collection systems. An important point to keep in mind is that UAS are not only less expensive for aviation operations but help reduce costs for other missions such as intelligence operations too. Captain Fassieux, an Army intelligence officer highlighted, "that it's another tool that is cost effective versus Human Intelligence (HUMINT) operations on the ground…it does not fully replace the HUMINT activity, but augments the process." According to him, the augmentation to the intelligence gathered in Afghanistan and Iraq by UAS has been invaluable. He further explains that HUMINT operations aren't only taking place during war but are also taking place in peacetime operations as well, particularly in areas where clandestine U.S. intelligence agents are infiltrating hostile territory and tracking insurgent operatives without the help of conventional forces and with limited resources (Fassieux, personal communications, September 11, 2010).

Although UAS operations have been developed over the last 9 years of war in Iraq and Afghanistan, UAS have proven their worth during peace operations too. For example, the uses of UAS with border patrol operations for detecting and tracking illegal immigrants along the U.S./Mexican border to capture drug smugglers and/or human traffickers has been a huge success. Furthermore, the Coast Guard has begun to utilize UAS in order to augment their operations, particularly for anti-drug missions. There is no question that UAS have a vast multi-mission capability that we're still discovering to this day.

Consideration of Support between UAS and Manned Aircraft

The individuals questioned in this survey responded 79.4% in favor of UAS extending the aerial reconnaissance and screening capabilities supporting the economy of force role during offensive, defensive, rear and retrograde operations better than manned aircraft. When tasked appropriately, information gleaned from UAS can assist in answering commander's intelligence requirements, regardless of the type of operations being conducted.

UAS can be an integral director in the cross-queuing of other assets, to include manned aircraft or ground based weapons systems bringing them all together as a force multiplier. They are an outstanding extension to reconnaissance; more eyes on the objective will always provide a better and more rounded out perspective of the battlefield. Furthermore UAS free up manned aircraft for direct attack missions. In doing so, they provide two dividends; timely intelligence and the indirect effect of greater reserves of strike assets. With a longer on-station time, UAS can provide reconnaissance and screening for longer periods of time than most manned aircraft, providing early detection to ground maneuver troops. However, like manned aircraft, on station time may be limited significantly with an armament load.

Timeliness of Information between UAS and Manned Aircraft

The majority, 67.6%, of respondents stated that they believe UAS provide timely combat information concerning the enemy and terrain throughout the AO and early warning against enemy observation or attack enabling intelligence officers and commanders greater C2 on the battlefield better than manned aircraft. However, a considerable amount of the population surveyed warned that there are can also be issues with UAS products that can leave much to be desired in terms of timeliness and C2. Although it isn't the statistical difference that was salient in response to this question, it was the comments that commanders, intelligence officers and aviators stated that were most striking.

Timely information can be fed directly from the sensors of an UAS to combat operation centers. When UAS operators are paired directly with commanders and intelligence officers, they are endowed with a greater SA through NRT video of what's occurring in a combat zone. The only relying factor is that an UAS is able to be airborne and the link remains unbroken. Arguably, for commanders and intelligence officers, there is less filtering of information that may occur through this application of battlefield C2 obtained through UAS.

The intelligence collection manager has the greatest impact on how UAS are tasked and utilized in order to answer the commander's priority intelligence requirements. If synched and managed properly, the most accurate and timely information can be gathered from UAS when it's tasked in direct support to the ground maneuver commander specifically. In this case, the commander has full control of the location, time and way in which the UAS is operated, as well as a direct link the real-time intelligence that is gathered from UAS. The operational concept has proven successful in both OIF and OEF, and is now the precedent for the Joint Direct Support of

Airborne Intelligence, Surveillance and Reconnaissance (ISR) concept that are currently in development by the Department of the Army.

According to Captain Blaschke, who served as the first deployed ERMP UAS Company Commander; UAS is the timeliest way of providing IMINT to commanders and intelligence officers. NRT full motion video can be displayed immediately from UAS split seconds after their sensors detect and handover the target of interest for optical tracking. This video can then be collected and analyzed immediately. Whereas, manned helicopters are currently unable to provide NRT full motion video for commanders and intelligence to view NRT. This doesn't include the imagery provided by manned intelligence fixed airplanes, which also provide NRT video capabilities. According to Captain Blaschke, helicopter pilots must translate what they see into words and convey these things via the radio. He points out several issues with reporting from manned pilots: wrong information through the communication process, untimely reports or failure to report as some of the issues associated with reporting from an aircraft by pilots. The NRT full motion video puts the SA in the hands of the commander or the intelligence officer without having to rely on the middleman aviator for information described over the radio. Captain Blaschke states that the greatest advantage that UAS has to manned aircraft, is the ability to allow commanders and intelligence officers, who aren't on-scene the ability to gain perspective as if they were there through a long-standing, perpetual stare over the battlefield (Blaschke, personal communications, September 1, 2010).

Conversely, Captain Blaschke acknowledges that manned aviators are able to perceive a much greater amount of sensory information than UAS at this time. He states that an aviator is able to view the battlefield from near to far in 360 degrees along with using their other senses such as hearing, smell and feel. The UAS is restricted to a top-down, wide-to-narrow-field of view without any other sensory perception of the battlefield. He hopes that in the near future, through the implementation of emerging technologies, this will change. In response to this, a senior Warrant Officer pilot replied, “I feel there is always going to be a need for an operator in the sky with the ability to be able to react immediately versus near real time. A live operator will never lose the ability to maintain his link…the operator has the opportunity to react immediately versus moments later; a manned pilot can continue to engage a mission even when radio connectivity is lost…an UAS can’t” (Martin, personal communications, September 15, 2010).

Several intelligence officers provided a glimpse into their frustration for utilizing UAS versus manned aviation assets. One intelligence officer surveyed warned that unless the UAS operators are sitting directly with the maneuver commander, which is not usually the case for support to Brigade operations and higher, there is often a delay in the intelligence flow due to reporting channels. Conversely when an aircraft is on station supporting direct action, that pilot is involved in that combat operation directly. For some of the intelligence officers surveyed, the ability to speak with a manned pilot on scene via secure radio was the preferred method of reconnaissance for targets of interest. Ground commanders and intelligence officers who were provided video links but no immediate means of directing the UAS asset, expressed frustration at the lack of quality that was actually being provided by UAS.

With a manned platform, you can redirect sensors, talk to the pilot in real time, or even develop a target or deconflict airspace in a much more expedient fashion. One intelligence officer stated that at the company level, receiving intelligence from a UAS feed was similar to playing a game of telephone. He described that during deployments he had to contact the BN intelligence officer, who would then contact the UAS team, in order to redirect the UAS or get clarification. Timeliness is crucial, and can either be the drive for the success or failure of a mission.

Assessment of SA between UAS and Manned Aircraft

Utilized primarily as an intelligence-based asset, the majority of respondents stated that UAS would be better to enhance a commander's SA than the manned aircraft. However, although in the minority, many of the respondents felt strongly against the notion that UAS provide situational awareness that compares with that of manned pilots.

Manned pilots maintain that an aviator's presence on the battlefield provides personal experiences from the cockpit that enables intelligence officers and commanders to better assess the situation. For example, a helicopter pilot, who has flown through a particular region, can sense whether or not the demeanor of the people in that area has changed through the familiarity of observing their behaviors over a period of time operating in their AO. Furthermore, a pilot's experiences with flying in a particular area can provide a sense of the weather patterns changing over the area and how the weather plays a factor on the ground better than a UAS can. Often times, the video perspectives provided through UAS feeds don't allow operators to gauge weather conditions and its impact on the terrain. Manned pilots are faster at providing accurate weather data for commanders and intelligence officers.

UAS are limited where there are significant amount of inclement weather conditions. For example, in Afghanistan, there were experiences in which UAS would not be capable of flying due to weather at the departure airfield, destination, or at altitude; whereas manned aircraft were able to take off and land in similar conditions. Although most Army UAS are medium-altitude aircraft, they lack the anti-ice and de-ice capabilities that are common on manned intelligence gathering fixed wing airplanes.

Although UAS can conduct surveillance and early warning missions with possibly better results due to their long loiter times, the manned pilot's ability to fly close to the ground and view the terrain, battlefield and weather from different angles provides greater situation awareness for commanders and intelligence officer's SA. According to a DIA Intelligence Officer, "UAS have their place…however, manned aircraft provide intelligence like being at the football game on the 50 yard line, while UAS are like simply watching the game from home."

Attack Capabilities between UAS and Manned Aircraft

The downing of a Special Operations Aviation Regiment Blackhawk in Mogadishu changed the U.S. foreign policy for the next 25 years. The range, endurance, stealth and removal of risk to manned pilots make an UAS desirable in certain attack situations. It is a safer way to conduct a deep attack being that UAS can go further into enemy lines to collect information and conduct attacks without risks to aviators.

One commander observed that the perpetual drone of UAS during IED emplacement patrols were enough to deter potential insurgents due to their perpetual presence versus the sporadic presence of manned assets (Jones, personal communications, September 1, 2010). The majority of survey respondents, 64.8%, agreed that UAS could be utilized to attack in depth in order to extend the influence of the force and dominate avenues of approach better than manned aircraft. The UAS can be employed to recon deep into an AO and laser-designate a target in places that could be considered too risky for manned aircraft to operate. Perhaps the greatest utilization is through Manned/Unmanned (MUM) teaming because it can be such a combat multiplier. The UAS assumes the responsibilities of precision, pre-planned targeting allowing the manned aerial weapons assets the freedom to maneuver for more random and sporadic targets.

While it's true that UAS can extend the force, it cannot dominate avenues of approach better than a manned aircraft. Manned aircraft provide the ability to more spontaneously change application of force with a greater variation of weapons, versus UAS. UAS are currently limited on the type of armaments they can carry due to their physical limitations. Manned aerial weapons teams are able to better provide security for ground forces being that pilots are able to more fluidly adapt to changing scenarios and employ their weapons.

53.2% of respondents disagreed that the UAS perform raids, air assault security and convoy security operations better than manned aircraft. Rather, they explained the remote control of the UAS was too distant to depend on during life and death situations. Responsiveness is key during security and attack operations. Most of the military leaders surveyed agreed that Kiowa Warriors or Apaches moving in sync with maneuver forces is the favored method of providing security from aerial assets.

However, although UAS cannot conduct convoy security, air assault security, raids or reconnaissance better than manned aircraft, it is important to keep in mind that the on-station time of manned assets is limited by the pilot's physical ability to continue flying and the fuel required to continue to stay aloft. It is up to the commander or the intelligence officer to decide whether or not they want the increased security capabilities of manned aircraft or whether they would rather have a greater time on station such that UAS provides.

Captain Blaschke provided an interesting observation from his deployment as a UAS Commander, about the culture of U.S. Army Aviation and aerial combat operations. According to most Rules of Engagement (ROE) Army aviators (who are commissioned officers) are either permitted to attack based on their own discrimination or call higher to request authorization to fire based on the circumstances. However, it is very rare if never at all that a enlisted UAS operator is empowered to the same extent; despite enlisted Infantry, Armor and Artillery soldiers having the ability to fire at their discretion when the situation deems necessary. He believes that this is due to the longstanding culture within the Army Aviation Branch and also reflects on the distrust in the enlisted soldier operator within what is a new realm for them—piloting. However, he feels that in order to fully realize UAS potential to their fullest extent, these long-standing ROE will have to change in order to enable the decision making processes of enlisted UAS operators to be empowered, making on-the-spot decisions, as opposed to have to wait on the approval to fire by an officer who may or may not be involved in the fight (Blaschke, personal communications, September 1, 2010).

Comparison of Expendability of UAS and Manned Aircraft

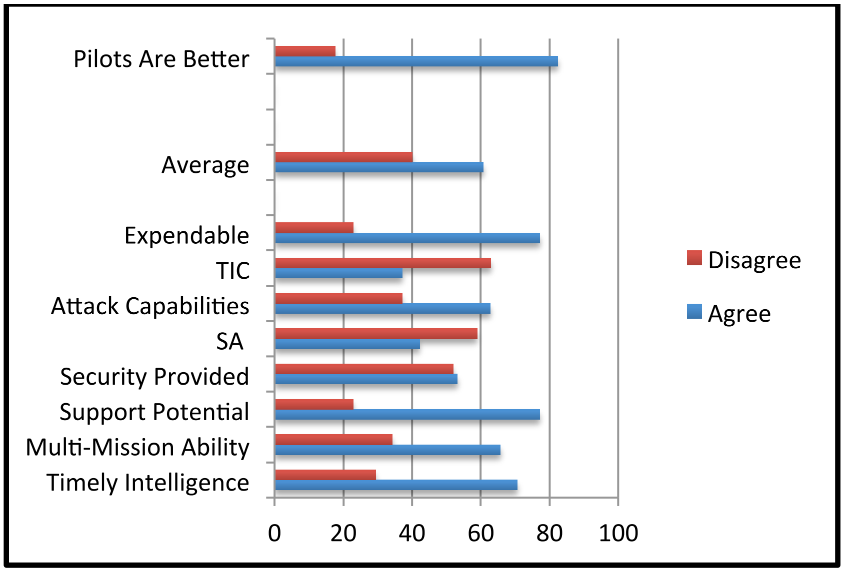
By far, the majority of this survey—74.3%, stated that they feel that UAS benefit commanders because of their expendability and low costs. Captain Joe Price, a Company Commander, explained that it costs a lot of money to purchase and maintain aircraft, a lot of money to train a pilot, and a lot of money and risk to try and recover a downed pilot. He believes that UAS are less expensive to acquire, less expensive to maintain and can be written off if shot down (Price, personal communications, August 27, 2010). One Intelligence Officer explained that this argument is certainly valid from the strategic viewpoint rather than the tactical. As a tactical commander, he would put greater emphasis on the vehicle that could best accomplish the mission. From the political and strategic level, the individual tactical mission is less important than the strategic and political implications of having a POW on the ground...particularly, if that aviator was involved in intelligence collection efforts behind enemy lines.

Support Capabilities for TIC between UAS and Manned Aircraft

The majority of respondents, 61.7%, stated that they do not believe that UAS can be utilized for protecting Troops in Contact (TIC). An individual who worked with the CIA pointed out that UAS can reinforce ground forces by fire but they cannot provide total security that is applied by manned aircraft. This time lag to act can impede the ability for the UAS operators to act quickly versus a manned aerial weapon system. The manned aircraft is in direct communication with ground forces, whereas, the UAS operator is in contact with some higher level of officers who are the authority approval for fires. Manned pilots can make critical decisions on scene without having to go through a higher echelon of approval for clearance to fire. A senior Aviation Warrant Officer sarcastically made the following point concerning UAS, “What's the payload of a UAS…a hellfire or two…any guns?…I don't even want to talk about the commo logistics involved…enough said.” He went on to say, “UAS do not carry enough ordnance however it may be used to direct call for fire missions with pin-point accuracy in terms of laser/range finding for manned weapons systems” (Walker, personal communications, September 7, 2010). One of the greatest advantages of utilizing manned pilots is the human element on the battlefield for attack operations by literally having eyes on the target and their instantaneous awareness of the conditions around them while they’re directly involved in the fight. The weapons payload is much greater on manned aircraft and the spontaneity in which a pilot can execute those weapons exceeds the current lag in timeliness required to gain authorization for UAS operators. The ability to assess situations, apply logic, and make decisions is key to attack missions. Manned aircraft performs attack missions, in most cases, better.

Survey Summary

The respondents clearly indicate that UAS operations, although still evolving through development, provide a positive asset for military commanders and intelligence officers to utilize on the battlefield. Although the majority of military leaders agree that pilots are still the preferred asset, UAS provide key strengths through their expendability, low costs and increasing abilities to getting missions completed successfully.



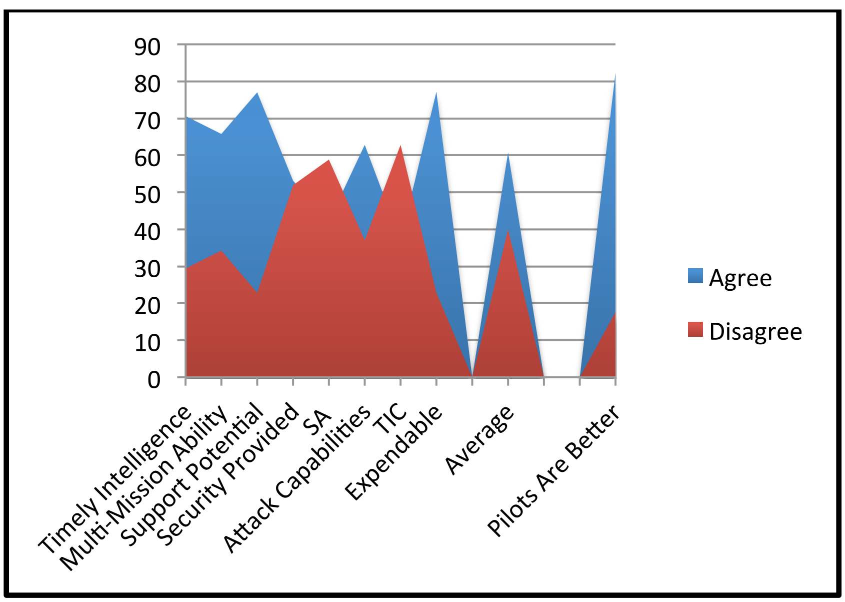


Figure 11. Summary of key survey results

Z-Test Comparison of Intelligence vs. Aviation Officers

Since many of the commanders in the survey population functioned as both intelligence officers and commanders or aviators and commanders or even aviators who served as both commanders and intelligence officers simultaneously; the following z-test highlights a comparison between intelligence officers versus aviators attitudes concerning UAS applications. The data provided through these z-tests proves interesting being that intelligence officers stand with the most to gain from the implementation of UAS technologies, whereas aviators obviously stand with the most to lose.

Of interest to these results, it's important to note that pilots, not intelligence officers were the most open-minded and supportive of the application to missions that they have flown and refined since Vietnam. On the other hand, these z-test results show that it was the intelligence officers, who in fact, prefer the utilization of pilots for the completion of their mission success.

When two independent samples are interviewed, there is some likelihood (confidence level) that the means obtained from the two groups (intelligence officers vs. pilots) are significantly different. If the value obtained from these tests is greater than the value for the given confidence level, the observed means are significantly different. The confidence level determines the level of confidence in the results. It tells the likelihood that the difference in proportions is not due to random chance. In these z-tests, 95% was chosen as the confidence level. It is assumed that the sample is a random and unbiased portion of the population and that the results are independent of each other.

Table 4

Z-test Results – Timely Intelligence

Timely Intelligence	
Intelligence Officers Population	6
Intelligence Officers % Agree	66%
Aviator Population	19
Aviator % Agree	68%
Z Value	-0.41
Actual Confidence Level	34.1%
Significantly Different?	No

Table 5

Z-test Results – Multi-Mission Capability

Multi-Mission Capability	
Intelligence Officers Population	6
Intelligence Officers % Agree	67%
Aviator Population	19
Aviator % Agree	44%
Z Value	0.514
Actual Confidence Level	69.7%
Significantly Different?	No

Table 6

Z-test Results – Support Potential

Support Potential	
Intelligence Officers Population	6
Intelligence Officers % Agree	83%
Aviator Population	19
Aviator % Agree	33%
Z Value	1.679
Actual Confidence Level	95.3%
Significantly Different?	Yes

Table 7

Z-test Results – Security Provided

Security Provided	
Intelligence Officers Population	6
Intelligence Officers % Agree	60%
Aviator Population	19
Aviator % Agree	47%
Z Value	0.087
Actual Confidence Level	53.5%
Significantly Different?	No

Table 8

Z-test Results – Situational Awareness

Situational Awareness	
Intelligence Officers Population	6
Intelligence Officers % Agree	60%
Aviator Population	19
Aviator % Agree	47%
Z Value	0.087
Actual Confidence Level	53.5%
Significantly Different?	No

Table 9

Z-test Results – Attack Capabilities

Attack Capabilities	
Intelligence Officers Population	6
Intelligence Officers % Agree	33%
Aviator Population	19
Aviator % Agree	63%
Z Value	0.819
Actual Confidence Level	79.4%
Significantly Different?	No

Table 10

Z-test Results – Troops In Contact

Troops In Contact (TIC)	
Intelligence Officers Population	6
Intelligence Officers % Agree	33%
Aviator Population	19
Aviator % Agree	31%
Z Value	-0.41
Actual Confidence Level	34.1%
Significantly Different?	No

Table11

Z-test Results – Expendability

Expendability	
Intelligence Officers Population	6
Intelligence Officers % Agree	50%
Aviator Population	19
Aviator % Agree	74%
Z Value	0.597
Actual Confidence Level	72.5%
Significantly Different?	No

Table 12

Z-test Results – Pilots Are Better

Pilots Are Better	
Intelligence Officers Population	6
Intelligence Officers % Agree	100%
Aviator Population	19
Aviator % Agree	73%
Z Value	0.856
Actual Confidence Level	80.4
Significantly Different?	No

CHAPTER VI

CONCLUSIONS

Benefits of UAS Technologies

UAS technologies provide an overwhelming force multiplier for combat operations. In particular, they increase the following for commanders and intelligence officers:

- Battle space awareness in terms of ISR
- C2
- Force application for engagement and maneuver operations
- Protection to troops

The relevance of UAS operations can be applied to irregular warfare, major combat operations, military support and security operations. Through the application of increased C2 and battle space awareness, UAS have successfully contributed to the defeat of terrorist networks and overcoming insurgent forces in both Iraq and Afghanistan. Furthermore, UAS have enabled commanders and intelligence officers the ability to better assess battlefield environments, strengthening C2. Therefore UAS have provided tactical commanders a dynamic, flexible, timely ISR capability in order to control and direct forces in an efficient and effective manner. The end state effect is that UAS empower commanders and intelligence officers with an improved ability to make decisions and plan, effectively utilize forces, limit risks and better protect the force while establishing dominance on the battlefield.

Through the application of manned and unmanned teaming, UAS have provided targeting support through the ability to detect, identify and track concealed targets in complex terrain and support various ground forces. In terms of the intelligence capabilities of UAS, they have provided the ability to conduct surveillance of specific or area targets of interest for extended periods of time (days or weeks).

Risks of UAS Procurement

However, as stated by a significant population of the respondents interviewed, it must be noted that there are risks identified with the implementation of UAS technologies. One of the most striking, and the premise of this paper, is the concern of the newly founded dependency on UAS technologies that are not fully mature at this point and their effect on replacing refined manned aviation tactics. Of all of the intelligence officers surveyed during this research, 100% of them stated that they prefer intelligence from manned pilots. However, only 73% of pilots agreed that manned assets were overall better at performing both intelligence and attack missions leaving a minority of that population open to UAS carrying out certain missions that put pilot's lives at risk. This data indicates that although intelligence officers may prefer missions to be carried out by manned pilots, it's the aviators, who because of the risk that is inherent to military aviators are more perceptive to UAS carrying out certain dangerous missions. Because of this, it is imperative that commanders develop the correct mix of manned and unmanned assets in order to establish a well rounded fighting force. No one can argue that UAS takes the human element out of the danger equation, however, as this survey suggests, there is still a demand for the attack and intelligence potential that manned pilots provide, nonetheless, military leaders who require aviation assets must carefully weigh the value of the asset versus the risk to human life. The quality of manned aviation has yet to be fully surpassed by UAS technologies. There will inevitably be missions that require the abilities of manned pilots regardless of the potential risks to human life.

Although UAS are expendable, they are not indestructible. A wide range of threat systems is becoming increasingly sophisticated, lethal and prolific and a growing number of worldwide entities are capable of attaining them:

- Surface-to-air missiles
- Small arms fire
- Signal jamming

However, this is the beauty of what UAS offer to military commanders. Machines now take on these inherent risks by removing pilots from these threats.

Precipice of Change

The advantages of manned pilots are significant and cannot be overlooked by Army commanders and intelligence officers. Army manned aircraft provide the following:

- The capability to conduct various missions ranging from intelligence to attack missions simultaneously due to greater payload capacity.
- Ability to fly near the surface of the earth and gain lateral visual perspectives that common UAS cannot.
- Increased lethality and accuracy as an attack asset.

Army manned pilots provide the following:

- Intuition, instinct and human senses directly applied to the battlefield.
- Ability to make strike and attack choices based on self-determining assessments, contingent on ROE.
- Superior ability to comprehend the entire battlefield.

We must carefully determine our path ahead and ensure that we don't abandon an invaluable benefit that manned pilots provide to the fight. We now stand at a quintessential point of historic change where the value of manned pilots may indeed be forever replaced with the emergent technologies and capabilities of UAS. In essence these changes are much like the days when the mounted cavalry had to hand over their horses for mechanized vehicles; a time, shortly after the Indian Wars, when proud steeds were put down and missions had to be carried out with new and disparate mechanized technologies.

Conclusion

The data has concluded that UAS have empowered commanders and intelligence officers with the capability to better understand the battlefield. This is shown through 60% of intelligence officers and 47% of aviators agreeing that UAS provide leaders with greater situational awareness. Approximately 63% of the pilots interviewed indicated that UAS could be successfully exploited in attack roles where human life is at greatest jeopardy. All things considered, this research has shown that the majority of commanders and intelligence officers believe that UAS provide military decision makers with an improved ability to assess, plan, effectively employ forces, limit risks and better protect the force while establishing dominance on the battlefield. Nearly 70% of both intelligence officers and aviators stated, throughout the course of this research, that UAS have provided the ability to better fight and win wars. The majority of officers questioned replied that UAS have proven themselves through effectively contributing to the defeat of terrorist networks in both Operations Iraqi Freedom and Enduring Freedom over the past nine years.

CHAPTER VII

RECOMMENDATIONS

Even though the progression of UAS technologies have proven capable of attaining amazing results, the fact of the matter is that with the current technologies there is still a need for a mixture of both manned and unmanned aerial systems. Both have their strengths and weaknesses, however, the challenge will be to implement both strategies into one encompassing approach to better attain the aviation mission goals of commanders and intelligence officers. In a Report on Technology Horizons 2010-2030, the chief Scientist of the U.S. Air Force, Werner J. A. Dahm stated, "although humans today remain more capable than machines for many tasks, by 2030 machine capabilities will have increased to the point that humans will have become the weakest component in a wide array of systems and processes. Humans and machines will need to become far more closely coupled, through improved human-machine interfaces and by direct augmentation of human performance" (Dahm, 2010, page 14).

As we have seen in recent times, UAS have been successfully implemented in strikes against an asymmetric, insurgent adversary that flourishes in environments that are considered adverse for regular soldiers to engage. The past nine years of a dual front war in both Iraq and Afghanistan have demonstrated that UAS have appreciably improved mission accomplishment, reduced soldier's workloads, and decreased their exposure to enemy contact. UAS are a proven asset for commanders and intelligence officers, broadening their SA on the battlefield making available an unprecedented ability to observe, target and destroy the enemy through NRT video, actionable intelligence delivered directly to their command posts. Never before has SA been greater with commanders and intelligence officers who now have the ability to see what is happening in combat zones as if they were actually there in the midst of the fight.

Whereas UAS better enhance commander's C3I than manned scout/attack weapons teams, manned pilots provide better security, raid, and attack capabilities. As stated earlier, an Army scout/attack helicopter pilot's heightened sense of surroundings is sharpened by the fact that their involvement on the battlefield puts them directly in harm's way. Manned pilots have been referred to, by the people interviewed for this research, as the guardian angels of soldiers who are under fire sharing the risk of putting their lives in harm's way. The moral obligation that pilots share with their brother's in arms while involved in the fight only increases their vigilance. This SA and bond with ground soldiers is something that UAS operators will never experience from the remote locations of their operating stations.

Conversely, there is no Army manned asset that can stay on station for prolonged periods of time, such as the Army's ERMP, providing a perpetual overhead stare over the battlefield, unfettered in nuclear, biological and chemical environments and able to provide continuous collection and targeting in uninhabitable atmospheres. The key is for commanders and intelligence officers to utilize both assets in order to maximize our nation's ability to fight and win wars.

Manned/Unmanned Teaming

The Army is currently utilizing both manned and unmanned aerial systems to work together in order to combine the inherent strengths of both platforms. The Manned/Unmanned (MUM) teaming concept combines sensors from both types of aircraft, linked with ground soldiers, providing greater synergy, enhanced situational awareness, greater lethality, improved survivability and sustainment. Properly utilized, the MUM compliment and extend the sensor capabilities of each other. The manned pilot can use the sensors of the UAS as extensions of the sensor capabilities he or she would have in their own aircraft for the acquisition and targeting of threats, allowing pilots to track and engage targets from greater distances and with superior accuracy. The data transfer between manned and unmanned systems reduces risk and increases mission effectiveness and survivability.

UAS offer 24/7 coverage of the battlefield, providing commanders and intelligence officers greater SA of the overall big picture than ever before and an alternative to overhead satellite systems. Helicopter armed reconnaissance and attack aircraft provide the ability to concentrate reconnaissance and attack operations with the greatest amount of SA, precision and lethality. The advantage of MUM is that commanders and intelligence officers now have the ability to maintain significantly increased vigilance across the battlefield while having the capability to strike with accuracy and lethality through manned crews. MUM assets can be tied together through comprehensive network, with an increased ability to detect enemy activities, quickly cross-queue intelligence and weapons systems, and defeat enemy forces with greater success than every before. Both remotely piloted aerial systems and manned aircraft have their limitations. However, when combined, the potential of both systems increase exponentially.

For example, Kiowa and Apache pilots are challenged with having complete situational awareness in urban environments combined with increased risks of exposure to an enemy that is either blended into the civilian populace or difficult to observe through the urban environment. Through MUM, the UAS becomes the eyes that can either send grid coordinates for the pilots or provide laser range finding/illumination for targets enabling pilots to mask themselves at a safer stand off distance without having to expose themselves in order to employ their weapon systems, which are then guided into the targets by the UAS. In essence, the pilot never even has to physically “see” the target, being that the UAS is providing that information while pilots are able to better conceal themselves while effectively engaging weapon systems.

The MUM concept has already paid big dividends in both Iraq and Afghanistan. MUM has not only been beneficial for strike and attack scenarios but has provided an extended range for airborne communications relays. These relays not only provide extended distances for radio communications for aviators but also facilitate the sharing of intelligence garnered from airborne sensors between aviation assets like never before. Satellites provide an eminent national asset; the IMINT and COMINT collected from UAS are surpassing the quality of these overhead sensors. This improved intelligence is now on tap and within reach of any aviator who is connected to the extended range of these airborne relays.

Experimental MUM Squadron

The Army is currently building an experimental Air Cavalry Squadron composed of 21 OH-58D Kiowa Warrior helicopters and eight RQ-7 Shadow UAS. The intent of this experiment is to test whether or not this arrangement will effectively allow the exponentially increased demand for aerial reconnaissance in combat zones with fewer forces over larger areas more efficiently. The concept of operations for this new hybrid squadron has been developed through feedback from deployed aviation soldiers flying Kiowas and Shadows in Iraq and Afghanistan. A key to the effort will be to equip the OH-58Ds with the ability to stream live video from the Shadow UAS. This experimental Cavalry Squadron will deploy to Afghanistan in 2012. If successful, the Army plans to convert three units per year to conform to this configuration until the entire force is standardized over a three-year period (Majumdar, 2010).

The desired outcome of UAS and manned assets combined, is to provide an operational synchronization of military forces in order to create maximum relative combat power at a decisive time and place. Tactical commanders require the ability to rapidly identify, track and destroy High Value Targets (HVT) and other threat forces in complex environments.

Collectively, manned and unmanned aerial systems allow commanders to best meet these requirements. Manned and unmanned operations provide previously unachievable levels of SA and firepower where U.S. and coalition forces are in direct contact with the enemy. The future of the U.S. Army aviation branch is to maximize the attributes of both manned and unmanned assets in order to fight and win wars.

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APPENDIX A

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APPENDIX B

DATA COLLECTION DEVICE

Comparison of the Value of Manned Aircraft Versus UAS for Reconnaissance and Attack Operations

1. Contact Information:

Rank & Name:
Email Address:

2. Please describe your rank.

Civilian (affiliated with military and or intelligence)
Senior Enlisted
Warrant Officer
Junior Officer (O-1 through O-3)
Field Grade Officer/Senior Officer (O-4 through O-6)
General/Flag Officer (O-7 through O-9)

3. Please describe your position (multiple choice/multiple answers).

Intelligence Officer
Pilot
Commander
Other

Please explain experience working with UAS.

4. Please describe your experience with UAS (multiple choice/multiple answers).

Piloted UAS.
Commanded a UAS unit.
Commander who utilized UAS to complete missions.
Intelligence Officer who utilized UAS for intelligence.
Flown manned/unmanned teams missions.
Worked with UAS indirectly.
Have not worked with UAS.

Please elaborate on your experience with UAS.

5. Do you feel that UAS provide timely intelligence concerning the enemy, terrain, and weather throughout the AO and early warning against enemy observation or attack better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

6. Do you believe that UAS can conduct operations across a wide range (peace, conflict, and war) against threats ranging in size from major regional powers, lesser powers, and terrorist groups to include insurgents better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

7. Do you believe that UAS extend the aerial reconnaissance and screening capabilities and supports the economy of force role during offensive, defensive, rear, and retrograde operations better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

8. Do you believe that UAS provide timely combat information concerning the enemy, terrain, and weather throughout the AO and early warning against enemy observation or attack enabling intelligence officers and commanders greater C2 on the battlefield better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

9. Do you feel that UAS perform C3I enhancement, surveillance, reconnaissance, raids, air assault security, convoy security better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

10. Do you believe that UAS operators have an equal situational awareness of the battlefield, as manned pilots, with today's technologies?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

11. Do you believe that UAS can be utilized to attack in depth in order to extend the influence of the force and dominate avenues of approach better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly

Why?

12. Do you believe that UAS can be utilized to reinforce ground forces by fire, protect the flanks of a moving or halted friendly main body and provide security for the movement and passage of lines by ground forces better than manned aircraft?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

13. Do you believe that UAS are better than manned aircraft for intelligence and attack missions because they are expendable and can be flown into dangerous environments without risk to human life or argument?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

14. Pilots are embedded, albeit from an aerial perspective, in the fight alongside ground troops and their senses and instincts are directly involved with what is happening on the battlefield. Comparatively speaking, UAS operators have a more remote and distant perspective of the battlefield. Do you believe that pilots on the battlefield provide a better solution for reconnaissance and attack operations than UAS operators because of the "human element" (the ability to assess situations, apply logic, make decisions and disagree with orders), which can't be replaced with technology?

Strongly Agree
Agree
Disagree
Strongly Disagree

Why?

APPENDIX C

LIST OF ACRONYMS

AAFSS – Advanced Aerial Fire Support System

AO – Area of Operation

ARL – Airborne Reconnaissance Low

CIA – Central Intelligence Agency

C2 – Command and Control

C3 – Command, Control and Communication

C3I – Command, Control, Communication and Intelligence

CRM – Crew Resource Management

DIA – Defense Intelligence Agency

ERMP - Extended Range Multi-Purpose UAS

FLIR – Forward Looking Infrared

HFACS – Human Error Analysis of Commercial Aviation Accidents and Classification System

HUMINT – Human Intelligence

HVT – High Valued Targets

IFR – Instrument Flight Rules

INT – Intelligence

IR – Infrared

ISR – Intelligence, Surveillance and Reconnaissance

LRF/D – Laser Ranger Finder/Designator

MDMP – Military Decision Making Process

MSL – Mean Sea Level

NVG – Night Vision Goggles

OEF – Operation Enduring Freedom

OIF – Operation Iraqi Freedom

OP – Observation Post

RF – Radio Frequency

RPG – Rocket Propelled Grenade

RSTA – Reconnaissance, Surveillance, Target Acquisition

SIGINT – Signals Intelligence

SA – Situational Awareness

SAR – Synthetic Aperture Radar

TA – Target Acquisition

TIC – Troops In Contact

TUAS – Tactical Unmanned Aerial System

TUAS – Tactical Unmanned Aerial Vehicle

TTP – Tactics, Techniques and Procedures

UA – Unmanned Aircraft

UAS – Unmanned Aerial System

UAS – Unmanned Aerial Vehicle

VFR – Visual Flight Rules

WAS – Wide Area Search