Strategy Research Project

USAF ROLE IN FUTURE AIR WARFARE: MANNED OR UNMANNED?

BY

LIEUTENANT COLONEL DAVID T. TRIMBLE
Idaho Air National Guard

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USAWC CLASS OF 2010

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U.S. Army War College, Carlisle Barracks, PA 17013-5050

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE *(DD-MM-YYYY)*
20-01-2010

2. REPORT TYPE
Strategy Research Paper

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

USAF Role in Future Air Warfare: Manned or Unmanned?

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Lieutenant Colonel David T. Trimble

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Colonel Phillip C. Tissue
Department of Military Strategy, Planning, and Operations

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army War College
122 Forbes Avenue
Carlisle, PA 17013

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

In today's volatile and complex environment, the military arm of national power has been called upon to fight campaigns in both Iraq and Afghanistan. For over eight years the USAF has been continuously deployed to both theaters, flying tens of thousands of sorties each year—mostly manned missions, but some unmanned. The unmanned flights are primarily for Intelligence, Surveillance and Reconnaissance (ISR) missions, but increasingly the unmanned platforms are used for attack missions. This increased reliance on Unmanned Aerial Systems (UAS) to fill more and more traditional roles of USAF air power has several implications. UAS eliminate the human aspect of being in the air. They do not provide direct situational awareness; they don't put "eyes-on" the target and the friendly forces. While UASs serve an important role, taking humans out of the cockpit will lead to strategic mistakes and give the enemy yet another opportunity to succeed. Fielding the right numbers of manned and unmanned aircraft will enable the USAF to effectively execute its mission in future conflicts. The uncertainty of the future environment and our continuing uses of USAF air power will require ingenuity, foresight, and appropriate technological development. As the enemy continues to adapt, so must we.

15. SUBJECT TERMS
ISR, UAS, Bandwidth, CAS, Forward Air Controller-Airborne

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
UNCLASSFIED	UNCLASSFIED	UNCLASSFIED	UNLIMITED	28	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

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Lieutenant Colonel David T. Trimble
Idaho Air National Guard

Colonel Phillip C. Tissue
Project Adviser

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U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: Lieutenant Colonel David T. Trimble

TITLE: USAF Role in Future Air Warfare: Manned or Unmanned?

FORMAT: Strategy Research Project

DATE: 20 January 2010 WORD COUNT: 5,582 PAGES: 28

KEY TERMS: ISR, UAS, Bandwidth, CAS, Forward Air Controller-Airborne

CLASSIFICATION: Unclassified

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USAF ROLE IN FUTURE AIR WARFARE: MANNED OR UNMANNED?

> Man—with his brain, his will, his soul—is not going to be replaced with mechanical miracles.
>
> —General William F. McKee, USAF[1]

In the current violent and hostile strategic environment, the role of the U.S. Air Force in air warfare is changing dramatically. Air power strategists have ushered in a new paradigm in the 21st century—Unmanned Aerial Systems (UAS).[2] The technological improvements and advancing capabilities of unmanned flight in the Air Force arsenal are quite impressive. UAS provide persistence, accurate Intelligence, Surveillance and Reconnaissance (ISR), and the recently developed capability to strike targets with precision-guided weapons. Commanders in Iraq and Afghanistan are requesting more and more Unmanned Aerial System (UAS) orbits; UASs are now used as weapons platforms. Just as helicopters came of age in the Vietnam War, UASs are maturing into force multipliers in current military operations.

As UAS become more prominent in the future and begin to assume more of the traditional roles of USAF air power, the Air Force must balance the force between unmanned and manned Mission Design Series (MDS) platforms. Overreliance on unmanned aircraft could have strategic consequences in future conflicts. According to a recent USAF document, the long-term evolution of unmanned capabilities will include full-autonomy and…"*a revolution in the roles of humans in air warfare*."[3]

This Strategy Research Paper (SRP) is not a reactionary diatribe questioning the enabling capability of UAS. Rather, it proposes a careful integration of UAS with other manned platforms to execute the wartime mission of the U.S. Air Force. It is about balance—putting the right blend of capabilities in the right place at the right time. It is

not about competing capabilities or the aura and glamour of flying. It is about flying, fighting, and winning America's wars in the most effective and efficient manner possible. This SRP traces the evolution of unmanned flight from the Vietnam War to the present. It discusses the UAS role in Air Force transformation. Then it compares and contrasts UAS limitations with those of manned flight in traditional USAF combat roles. It concludes with recommendations for a future blended force of both manned and unmanned aerial systems. Technology can greatly enhance human performance, but it can never completely replace the mortal element.

The Evolution of Unmanned Flight

UASs made their debut during the Vietnam War; they were used for surveillance and reconnaissance. The U.S. Air Force developed a drone reconnaissance program that used C-130 aircraft to launch drones guided by preprogrammed flight profiles over enemy occupied territory. Used primarily for surveillance, the drones provided an innovative method for obtaining critical information about the enemy. The Air Force quickly realized the new-found potential provided by the unmanned drones, so it initiated an acquisition process to develop a new, more capable version of the drone. The newly developed drone became the Lightning Bug UAS. The original Lightning Bugs were designed for high-altitude photo-reconnaissance and they had improved navigation and surveillance equipment. The newly designed UASs eventually adapted to other roles including electronic intelligence-gathering and electronic countermeasures (ECM) missions. Overall the UASs flew more than 3400 day and night support missions throughout the remainder of the Vietnam conflict.[4]

After the Vietnam conflict and the emergence of surveillance satellites with near real-time capabilities, the impetus for continued UAS development waned. The defense

budget, as it often does following a conflict, decreased and included very few appropriations for UAS development.[5] Then in the early 1980s, Israel developed several new UAS designs and demonstrated their successes. U.S. interest quickly revived. During Operation Peace for Galilee in 1982, Israel used UASs to locate Syrian surface-to-air missile (SAM) sites and to detect their radar frequencies. Manned Israeli aircraft, using the newly gathered electronic signatures, attacked the Syrian missile sites firing anti-radiation missiles. Along with supporting artillery fire, these air attacks destroyed the Syrian missiles.[6] After this successful campaign, the United States began to purchase unmanned systems from Israel and pursued further joint development.[7]

Through procurement and development by the U.S. Navy, the Israeli-made Pioneer proved useful in Desert Storm by providing valuable tactical level intelligence information on Iraqi targets.[8] The demonstrated capability of Pioneer during Desert Storm led to the U.S. Air Force Advanced Concept Technology Development (ACTD) of the RQ-1 Predator, which are then used in the Balkans. Although initially assigned to gather intelligence information for the North Atlantic Treaty Organization (NATO), the Predator demonstrated its potential by providing the first live video feeds of air warfare directly to the Combined Air Operations Center (CAOC).[9] The RQ-1 Predator's performance in the Balkans led to increased development and innovative new ideas and roles for UASs.

After the successes of the Predator in the Balkans, Air Force leaders envisioned greater UAS roles, even attack missions. Modifying UASs to carry lethal weapons was similar to the installation of guns onto World War I bi-planes.[10] When the Air Force

decided to arm the Predator, its nomenclature changed from RQ-1 to MQ-1 to designate its multiple capabilities. The MQ-1 would continue to provide ISR, but it would also strike targets with precision guided munitions. In May 1998, an upgrade contract was awarded to General Atomics Aeronautical Systems to increase the capabilities of the already lethal Predator. The newly designed system was originally called the Predator-B, but eventually evolved to the MQ-9 Reaper, larger and more capable than the MQ-1 Predator. The Reaper carries up to four Hellfire armor-penetrating missiles plus a mix of laser-guided bombs (LGB) and the Joint Direct Attack Munitions (JDAM).[11]

In February 2001, a Predator successfully fired an AGM-114 Hellfire missile in flight tests at Nellis Air Force Base, Nevada.[12] UAS technology had matured: Non-lethal reconnaissance UASs had developed into heavily armed platforms for precision-guided weapons. The true testament to their lethality came in November 2002, when a Predator operated by the CIA successfully engaged and destroyed a vehicle carrying six al-Qaeda terrorists with a Hellfire-C laser guided missile in Yemen.[13] Remote-controlled means of attacking the enemy on the battlefield had come to fruition.

As technology flourishes, the tendency to want bigger and better systems with more and more capabilities seems to be the rule. The next UAS to be developed as part of the Air Force arsenal was the RQ-4 Global Hawk. It had its first test flight in February 1998, and transitioned from an ACTD to engineering and manufacturing development in March 2001. Compared to the Predator, the Global Hawk is larger, can fly higher and stay airborne longer, and it has an increased payload. The sensor payload on the Global Hawk consists of an all-weather synthetic aperture radar (SAR) with a moving target indicator (MTI), an electro-optical digital camera, and an infra-red (IR) sensor that

provides steadfast day and night coverage. The Global Hawk can fly above 60,000 feet, stay aloft for more than 24 hours, and provide persistent ISR coverage and strike capability to ground units and commanders.[14]

However, even with the overall successes of Global Hawk, Predator, and other UASs, their safety record and cost of production have aroused concerns among civilian and military leaders. In the executive summary of the 2004 DOD Defense Science Board on Unmanned Aerial Vehicles, a Task Force identified two areas that needed to be changed: Cap unit production costs and reduce mishap rates. Without changes in these two areas, the Task Force noted, the potential of UAS's will not be realized.[15] The report further stated that UASs will lose their utility if cost becomes unwarranted, especially in high threat areas in which adversaries can destroy UASs. Further, UAS mishap rates were significantly higher than those of manned platforms due to power and propulsion failures, flight control malfunctions, and accidents on takeoff and landing caused by human errors.[16]

USAF Transformation Plan for UAS

The U.S. Air Force has always been acknowledged for its technological dependence. From the first manned flight by Orville Wright in 1903 to the current air war over Iraq and Afghanistan, the Air Force has been ever evolving technologically. Beginning with dumb bombs dropped with unsophisticated "iron sights" during World War I over Europe to the evolution of putting a 500-pound laser-guided bomb through the third window on the second floor of a building in downtown Baghdad, the USAF has embraced its war-fighting technology. Unmanned flight represents another technological leap in the persistent development of USAF capabilities, and the recent conflicts in Iraq and Afghanistan have fueled an insatiable appetite for more and more unmanned

platforms. The Air Force's proposal for development and implementation of a variety of UASs into greater air power roles and missions is a grandiose vision.

In May 2009, an unclassified version of the *United States Air Force Unmanned Aircraft Systems Flight Plan* was distributed by headquarters, United States Air Force, in Washington, DC. This plan projects the future of UASs through 2047, which coincidentally, is the 100th anniversary of the USAF. This Flight Plan articulates this grandiose vision: "*Where UAS are considered viable alternatives to a range of traditionally manned missions".*[17] The range of proposed unmanned vehicles to be developed over the next 37 years is diverse: it encompasses small, medium, and large platforms. These "fighter sized" vehicles, "tanker sized" vehicles, and "special" vehicles with unique capabilities, will evolve into fully autonomous operational status, ultimately replacing humans in the cockpit.[18]

One of the 10 key assumptions that guide the USAF Flight Plan is that of potential cost reductions.[19] Developing and implementing cheap surrogates to manned aircraft that perform the same roles and missions seems to be a fiscally smart decision. However, according to the November 2005 Report to Congress on Unmanned Aerial Vehicles, DOD spending on UAS development increased from $284 million in FY 2000 to $2.1 billion in FY 2005;[20] an increase of over 700% in just five years. Also, in a recent DOD estimate on the Global Hawk acquisition program, unit production cost was $128 million per UAS; cost overruns have already totaled $194 million—hardly a cheap alternative to manned aircraft.[21] Additionally, as UASs increase in size and capabilities, their procurement costs, along with support requirement costs, will also increase. The road ahead will include budgetary considerations not only for acquiring new UASs but

also for training, manpower, operations and maintenance (O&M), as well as secure satellite data-link usage. These costs, along with the acquisition toll, will continue to grow at a rate significantly higher than inflation.[22]

Beyond the continued acquisition of Predator, Global Hawk, and Reaper, the immediate actions cited in the USAF Flight Plan include assessing UAS options for supporting multiple Combatant Commanders, standing up two small unmanned aircraft system (SUAS) squadrons, and defining Air Force Specialty Codes (AFSC) for UAS personnel career paths and leadership opportunities.[23] The 19 immediate-action items identified in this Report pave the way for follow-on portfolio option proposed to be capable of supporting many, if not most, USAF air power roles.

Evolution

The USAF Flight Plan breaks down the UAS evolutionary process into near-term, mid-term, and long-term actions. Near-term actions focus on increasing operational efficiencies, doctrinal changes that clarify and strengthen the chain of command, training efficiencies, and communication network issues.[24] As UASs are more widely used, their operational effectiveness and on-going integration into the network-centric war-fighting environment will be much more pronounced. The communications architecture that enables operators to remotely fly unmanned aircraft is very complex; it is essentially the “life-line” to their operational success or failure. As unmanned systems become more sophisticated, the required network infrastructure and bandwidth[25] that enables their capabilities must also evolve. The finite bandwidth now available for all military aircraft and future competition for existing bandwidth “may render the expansion of UAS applications infeasible and leave many platforms grounded.”[26] Strategic leaders

and communication planners must analyze this communications problem and devise mitigation technologies to overcome these obstacles.

Mid-term goals cited in the USAF Flight Plan concentrate on accelerating innovation and expanding acquisition toward a final end-state of full autonomy. In the 2006 Quadrennial Defense Review (QDR), Secretary of Defense Rumsfeld declared that “Successful modern businesses are leaner and less hierarchal than ever before. They reward innovation and they share information. They have to be nimble in the face of rapid change or they die”.[27] His observation applies to the USAF vision for UAS. The current acquisition system is dispersed among several individual programs, and program managers are held responsible for only their separate programs. So there is often no incentive to go beyond requirements; consequently, innovation is capped at the lowest common denominator of technological development.[28] Further, some members of Congress oppose the development and acquisition of UASs among all the military services; they are calling for centralized control of acquisition authority to ensure unity of effort and to reduce duplication of effort. Yet others claim this proposed centralized effort will suppress competition and stifle innovation.[29] The USAF needs adept strategic leadership and industry expertise to help evolve UASs toward the stated goal of developing fully autonomous UAS capabilities.

The long-term Air Force goals for UAS call for their total integration into U.S. military assets and their capability to operate fully autonomously. In air defense, Autonomy is described as the mode of operation assumed by a unit after it has lost all communication with higher echelons.[30] To be fully autonomous, UASs must be auto-programmed to take off, fly to their designated area of operation, conduct their war-

fighting mission, defend themselves from all attacks, return and land at their home base—all of this without assistance from outside agencies and without human intervention. The Air Force postulates that the final step in their long-range vision is development of UASs' capability for full autonomy, hypersonic[31] technology, automated maintenance, automatic target engagement, and the ability to keep the enemy off balance with almost immediate battle space effects. As the USAF Flight Plan readily claims, "*The end result would be a revolution in the roles of humans in air warfare."*[32]

UAS Limitations

The Air Force's heavy reliance on future unmanned capabilities warrants careful scrutiny. History has shown that an overreliance on technology and a haphazard advancement of new technologies can lead to disastrous results.[33] Strategic leaders must not forget history; they must approach new technological "revolutions" with prudent caution. P.W. Singer astutely warns us that "*the first to invent or take advantage of some revolutionary new weapon…tends to come out behind in the final calculus."*[34]

The Air Force should address several issues before committing to fully autonomous UASs. Concerns such as integrating UAS's into the National Airspace System (NAS), collision avoidance with other manned and unmanned aircraft, air-to-air refueling operations, employment of UASs in contested airspace with multiple air-to-air and surface-to-air threats, adhering to complex rules of engagement and other legal issues, and dealing with the dynamic complexity of the "fog of war"—all such issues need to be resolved before fully autonomous operations can be implemented.

Several obstacles must be overcome before UASs can operate safely in the increasingly congested U.S. airspace. Unmanned aircraft systems do not currently have the same capabilities of manned aircraft to safely and efficiently operate within the NAS;

only on a case-by-case basis have they been allowed to operate outside military restricted and warning areas. Obtaining permission to operate outside military-only areas is time consuming and can be costly because UASs lack the capability to “see and avoid” other aircraft. Chase planes or primary radar coverage is required to enable UASs to operate in congested airspace.[35]

In manned aircraft it is the inherent duty of the pilot-in-command to see and avoid other aircraft. In the NAS, the Federal Aviation Agency (FAA) controller provides guidance on altitude, headings, and route of flight information; the controller directs the pilot to turn, climb, or descend to avoid other traffic. However, none of these directives prevents the pilot from taking evasive action to avoid a mid-air collision if “unknown” traffic appears that was not noted by the controller, but suddenly becomes a factor. This obligation pertains not only to avoiding a mid-air collision with another aircraft, but also collisions with the ground and other hazardous obstacles. One of the major challenges of integrating UASs into the NAS is developing a “see and avoid” capability that enables UASs to avoid conflicting air traffic, hazardous weather, terrain, and other obstructions.[36]

One of the greatest capabilities of unmanned aircraft is their persistence. But sooner or later, “what goes up must come down.” Some UASs can stay airborne for over 24 hours to provide uninterrupted observation of the target area or to destroy targets. But if commanders need continuous, uninterrupted coverage, they must launch replacement vehicles or refuel the ones already operating. It is certainly plausible that USAF KC-10 and KC-135 aerial tankers could soon be replaced by UASs providing aerial refueling to manned aircraft. In fact, the DOD UAS Roadmap 2005-2030

proposes that fully automated aerial refueling capability by UASs will exist between 2010- 2015.[37] The next step is to design UASs to refuel from other UASs. Continued design modification and testing will be necessary to develop the control mechanisms required for the coordinated orchestration of unmanned-to-unmanned aerial refueling.[38]

Reliance on satellites, the communication infrastructure, bandwidth, and distributed common ground stations (DCGS) needed for successful operation may increase UAS vulnerabilities in future conflicts. Electronic jamming or physical destruction of satellites used for UAS operation could render the unmanned fleet directionless and dysfunctional. Recently the Chinese demonstrated its capability to shoot down an aging satellite orbiting more than 500 miles above the earth.[39] A cyber-warfare attack on the U.S. digital infrastructure would have devastating strategic effects on our nation and the military UASs fighting our battles. President Obama recently stated that the cyber threat we face is one of the gravest challenges to our national security.[40] Bandwidth is limited and demand is growing exponentially. Some sources say that our military can download video and radar images via satellites from only one UAS at a time; they believe existing demands may halt expansion of capabilities and ground many platforms.[41] Ground stations used for mission planning, launch and recovery, intelligence gathering, and controlling actual missions will need continued protection to thwart adversaries' attacks. These and a variety of other issues need resolution for successful implementation and autonomous operation of UASs.

UASs have been conducting combat operations for more than 8 years in a relatively benign environment. Their proven ability to provide ISR and strike targets has been impressive. But they have been uncontested. In a high threat theater of operations

against a formidable foe, UASs will surely face more daunting challenges. In a heavily contested arena, UASs will need the ability to “sense and avoid” other traffic, to find the refueling platform, and to conduct aerial refueling operations. They must be able to enter the target area while defeating the air-to-air threat and while successfully defying surface-to-air missiles and anti-aircraft artillery. Then they must precisely employ lethal force against the enemy while distinguishing between friend and foe. Then they must fight their way home. The challenges will be daunting.

Implications of an Improper Balance

As stated in the introduction, the USAF needs to determine and maintain an appropriate balance between unmanned and manned platforms. An imbalance of MDS aircraft could lead to strategic mistakes. For the past 8 years the United States and coalition forces have waged war against an enemy that does not fight conventionally. They don’t wear uniforms, they use non-combatants as human shields, and they hide amongst the local populace in schools, mosques, and hospitals. Our ability to acquire precise, persistent intelligence has helped immensely in tracking, targeting, capturing, and sometimes killing of our adversaries, no matter where they hide or how they dress. UAS capabilities in the Iraq and Afghanistan theaters of operation have been very successful in this kind of war, but what about the next conflict? Will an arsenal of UASs expected to fill most traditional roles of USAF air power be the right choice? Italian General Giulio Douhet advocated that the way to win the next war was not to fight it like the last one: "Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."[42] Our nation is waging a rapidly changing war. We are adapting each day to the present

conflict. But we also need to heed Douhet's advice and anticipate the changes in the character of the NEXT war. We must not "put all our eggs in one basket."

The Global War on Terror (GWOT) has greatly enhanced the role and value of UASs. Their successes over the last 8 years have stirred an unquenchable thirst for further development, acquisition, and implementation. Two of the main reasons for aggressively pursuing unmanned flight are their low cost and the decreased risk of loss of human life.[43] When UASs were initially deployed, they were considered expendable assets. They were relatively inexpensive. Their loss was considered negligible. As UAS technology increases and their capabilities expand, the size of the vehicle increases in order to carry larger and more sophisticated payloads and to increase their survivability in high threat areas. Larger UASs are being designed to fulfill multi-mission roles of strike, persistent strike, armed reconnaissance and electronic attack in both lightly and heavily defended areas. Their increased size, their more elaborate sensor suites, and their expanded weapons load have greatly increased their cash value and no longer make them a low cost solution.[44] UASs are no longer expendable. They have become top-shelf military items.

It is obvious that the risk of human life would not be a consideration in a "man-less" aircraft. If the aircraft goes down, there is no human toll—simply the loss of an increasingly expensive sophisticated machine. Downed UASs are easy for the American public to stomach and nothing much for the media to report. Politically, war and conflict are much more palatable when they waste fewer lives, especially friendly lives. Although the risk of loss of life decreases with the usage of UASs, losing a military asset is still a great loss. When a UAS is lost in combat, strategic leaders and

commanders need to analyze these failures: How and why did the machine crash? Was the cause operator error, or a mechanical malfunction? Was it shot down by enemy integrated air defenses (IAD), or did it crash due to inclement weather? Did it have a mid-air collision with another UAS or manned aircraft? Were the satellites necessary for UAS operation jammed or destroyed? Would the circumstances be different if a manned aircraft was performing the mission? Such questions beg for comparisons between manned vehicles and UASs. Can we afford predictable losses of computerized, technology-dependent UASs? Or is the cognitive power resident in manned aircraft more appropriate for achievement of our national military objectives? Indeed, where it comes to our national military strategy, we do put a cost on human lives.

Human cognition gives us the ability to use reason, to make judgments, and to react to any given situation. Using experience and intuition, with acute awareness of the situation, humans can act instantaneously and decisively—necessary qualities in the dynamic, complex, and oftentimes chaotic nature of warfare. Some claim that within the next 5-20 years computers will have the capability to process information and make decisions similar to that of humans. For UASs to achieve this potential and operate fully autonomously, their mission management computers must rival the speed, memory, and thinking patterns of the human brain.[45] It seems unlikely, however, that mega-computers with speeds and memory equal to that of the human mind could ever activate the innate abilities, cognitive thought processes, or integration of empirical data necessary to make humans' split-second decisions. Military planners should consider the human factor to arrive at an appropriate balance between both manned and

unmanned platforms and the mission roles both must fill to ensure success in future conflicts.

The next war the United States is involved in may be the same or very similar to the one we're engaged in now; a war against another failed state or non-state actor that relies on Irregular Warfare (IW) with no air-to-air threat and a relatively insignificant surface-to-air threat. But, the next war could be a conventional conflict against a near-peer nation-state such as China, which is generally seen as an emerging superpower challenger to the United States[46], or Russia, or North Korea, or Iran. Against such opponents, air superiority[47] would not be guaranteed—at least not initially. These potential adversaries have formidable capabilities to challenge the U.S. in the air-to-air arena. U.S. forces would need to establish air superiority so conventional land and sea forces could conduct operations unimpeded.

Is air-to-air combat an appropriate mission for an unmanned aerial system or one more suited to a manned F-15, F-22 or F-35? The most likely engagement for a UAS would happen beyond visual range (BVR), following appropriate identification of a hostile aircraft. A UAS missile would destroy the target from maximum range. Case closed. In March 2003, a Predator armed with a Stinger air-to-air missile shot at an Iraqi MiG-25 Foxbat and missed; soon after the Predator was shot down by the Iraqi aircraft.[48] In future scenarios, if an adversary aircraft averts the air-to-air missile and closes within visual range, dynamic, 3-dimensional maneuvering would be necessary to achieve a second shot and score a kill. Within visual range, the UAS would need to visually identify (VID) the enemy aircraft as hostile, maintain sight of the maneuvering adversary, all the while maneuvering around the enemy to avoid fire and to gain a

favorable firing position. Positively identifying an enemy aircraft in the visual arena is a difficult task that can be hampered by environmental conditions, by the assessed energy state, by spatial orientation, and by a variety of other factors. A human pilot is more capable of making this identification than is any current remote-controlled UAS.[49] In the complex environment of air-to-air maneuvering, with the necessary requirement to VID, to maneuver in relation to the adversary, to keep continual sight of the enemy aircraft, and to position your aircraft within the weapons engagement zone (WEZ) to take a successful shot, the manned aircraft is the better choice.

Proponents also claim UASs can operate successfully in the dynamic environment of Close Air Support (CAS). With traditional CAS platforms like the A-10, F-16 and AC-130 approaching the end of their useful service lives, UASs may be chosen to fill the void.[50] With sophisticated sensors, precision weapons, and the ability to stay aloft for great periods of time, the UAS appears to be the logical choice to replace these legacy aircraft. But with what accuracy can a UAS flying autonomously distinguish an enemy target from a mosque or a school? Target recognition technology presently relies on matching sensor information with predictive templates.[51] When the sensor information matches the template, target recognition and confirmation are supposedly complete, so lethal ordnance is delivered on the target. However, disastrous strategic results could arise if the intended target has been identified as a SCUD missile loaded on a transportable-erector-launcher (TEL), but turns out to be a school bus loaded with children parked in a schoolyard.[52] The information required to make the decision to employ weapons must be assimilated by onboard UAS computers secure from spoofing or jamming by the enemy. The UAS computers could identify an enemy; they could also

verify that no friendly forces are in proximity to the target. And they could be wrong. A human pilot has greater capability of rectifying this situation than does a computer-driven UAS. Decisions of this magnitude could never be fully trusted to UASs.[53]

As the level of complexity and ambiguity rises while ground troops are engaged in close proximity with the enemy, the necessity to deal with such issues also becomes more critical. The ability to sift through the “fog of war” and make crucial decisions is paramount. A pilot in a manned aircraft gains situational awareness of the situation and coordinates threat information, targets to be attacked, locations of friendly forces, type of control to be used, etc., with the Joint Terminal Attack Controller (JTAC). This pilot also must be prepared to respond to any number of contingencies, such as lost communications, the enemy overrunning the friendly position, emergency procedures in case the JTAC is killed, troops in contact (TIC), etc. If friendly ground forces are receiving effective fire from the enemy, the JTAC will declare a TIC situation as an advisory call to increase awareness of the urgency of the situation.[54] During a situation where enemy troops are in close proximity to friendly forces, ordnance must be carefully selected along with the attack axis and type of control to be used. If a Type 1[55] control were deemed necessary, only a manned platform could engage the enemy and potentially save the lives of friendly forces.[56]

Based on the successes of UASs over the last eight years, advocates will probably cite the need for unmanned platforms to fill the role of Forward Air Controller-Airborne (FAC-A). Of all the missions the USAF performs, the mission of the FAC-A is unarguably one of the most demanding. According to Joint Publication 3-09.3, the role of the forward air controller “is to exercise control from the air of aircraft and indirect

fires engaged in close air support of ground troops...and will be recognized across the Department of Defense as capable and authorized to perform terminal attack control[57] (TAC)."[58] Only specially trained aviators with vast amounts of experience can safely and effectively orchestrate the air and land war simultaneously. FAC-As are responsible for integrating air and surface fires, coordinating efforts with ground elements, deconflicting numerous air assets within confined airspace, locating and marking targets, and providing terminal control of attacking aircraft while ensuring prevention of fratricide. Several limitations of UASs—such as restricted sensor field of view (FOV), communication and video delays, speed and maneuverability required to defeat ground and air threats and response time in critical situations—make it unlikely that they could assume the dynamic role of Forward Air Controller-Airborne.[59]

Recommendations and Conclusion

As stated several times throughout this paper, UAS achievements over the preceding eight years have been dramatic. They have provided valuable intelligence. They have demonstrated the ability to persistently and precisely locate, track, and sometimes kill or facilitate capture of the enemy. These are valuable and impressive contributions to current military operations. This evolution in capability will continue to give commanders important information about the enemy; it will give them an advantage over future adversaries in forthcoming conflicts. But this newly found capability cannot be considered a panacea, or "silver bullet", for all future wars. A balance in capabilities, roles and platforms will enable the United States to be successful no matter what enemy we face.

In future conflicts, USAF platforms must be designed to conduct warfare no matter what the conditions—conventional or unconventional, uncontested or contested.

As UASs are flying multi-role ISR and CAS missions this very moment overseas, they are operating in relatively uncontested conditions. The only real threat they encounter comes from potential mid-air collisions with other coalition assets.[60] Future aircraft procurement efforts should focus not only on the current fight but also on the future fight with a more formidable foe.

UASs are well suited for the Intelligence, Surveillance, and Reconnaissance role; they continually provide critical, enabling information that provides an advantage on the battlefield. Continued research and development of these unmanned capabilities will only increase the awareness of the combat situation. Future UAS roles in Electronic Warfare (EW), Suppression of Enemy Defenses (SEAD), air-to-air refueling (AAR), and deep-strike interdiction should be considered: UASs may well perform some of these roles. However, for the foreseeable future, some critical Air Force missions will require humans in the cockpit.

In the air-to-air arena, the U.S. military needs to continue development of platforms like the F-22 and the F-35; it should also continue research and development of a future generation of air superiority fighters. Many Air Force generals and other senior leaders believe that the F-35 Lightning II Joint Strike Fighter (JSF) will be the last manned fighter ever built; the Air Force is scheduled to purchase its last JSF in 2034.[61] If the Air Force and the DOD continue to invest more and more into UASs to fill the role of air-to-air fighters, future conflicts could catch the military off guard and allow the enemy to gain air superiority and an eventual victory.

In a dynamic and volatile high-threat environment that may produce a fierce air-to-air and surface-to-air threat situation, our commanders will need manned platforms;

with UASs providing force enabling capabilities. UASs are incapable of performing several critical missions: counter-air[62], CAS, and FAC-A. Until UASs develop much more sophisticated capabilities, manned aircraft must be available to perform these missions. A well-balanced mix of unmanned platforms performing ISR, EW, SEAD and AAR missions would nicely complement the manned USAF inventory of the future and give commanders viable options to succeed in battle.

In the volatile, uncertain, complex, and ambiguous environment of war, only human capabilities will be able to overcome inherent obstacles in future air warfare. Experience, cognitive skills, and intuition enable the human in the cockpit to sift through the fog and friction of war and delineate between friend and foe, valid or invalid targets. In the chaos of war, "military leaders have always recognized that reality and no amount of computing power will eradicate this basic messiness."[63] To avoid strategic failures in the future, it is essential that strategic leaders focus on the contributions of humans in planning a well-balanced approach to sustaining USAF air power.

Endnotes

[1] U.S. Air Force, *Quotes for the Air Force Logistician,* (Maxwell Air Force Base, Alabama, Air Force Logistics Management Agency, October, 2008), 89.

[2] There are varying terms for unmanned aircraft. UAS refers to the entire system; aircraft, ground station, and associated launchers. Unmanned Aerial Vehicle (UAV) denotes the actual aircraft. Other documents, such as the DOD's *Unmanned Aircraft Systems Roadmap, 2005-2030* use the term Unmanned Aircraft (UA). For clarity this paper will just use the term UAS when describing either the entire system or just the unmanned aircraft.

[3] U.S. Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan, 2009-2047*, (Washington, DC, Headquarters, United States Air Force, May 18, 2009), 50. Hereafter referred to as USAF Flight Plan 2047.

[4] Bill Yenne, *Attack of the Drones: A History of Unmanned Aerial Combat,* (St. Paul, MN, Zenith Press, 2004), 25-26.

[5] U.S. Air Force, *The U.S. Air Force Remotely Piloted Aircraft and Unmanned Aerial Vehicle Strategic Vision (*2005), 1-2. Hereafter referred to as U.S. Air Force Strategic Vision, 2005.

[6] Ralph Sanders, "An Israeli Military Innovation: UAS's", Joint Force Quarterly (Winter 2002-2003), 115.

[7] U.S. Air Force Strategic Vision, 2005, 2.

[8] Elizabeth Bone and Christopher Bolkcom, *Unmanned Aerial Vehicles: Background and Issues for Congress,* (Washington, DC, Congressional Research Service, 2003), 2.

[9] David B. Hume, *Integration of Weaponized Unmanned Aircraft into the Air-to-Ground System,* Air War College Maxwell Paper (Maxwell Air Force Base, AL: Air University Press, September, 2007), 4.

[10] U.S. Air Force Strategic Vision, 2005. 6.

[11] Air Force Technology Home Page, http://www.airforce-technology.com/projects/predator, (accessed October 24, 2009).

[12] Ibid, (accessed October 25, 2009).

[13] Ibid, (accessed October 25, 2009).

[14] Department of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030,* (Washington, DC" Office of the Secretary of Defense, August 4, 2005), 6. Hereafter referred to as Unmanned Aircraft Systems Roadmap 2005-2030.

[15] Department of Defense, *Defense Science Board Study on Unmanned Aerial Vehicles and Uninhabited Combat Aerial Vehicles,* (Washington, DC: Office of the Undersecretary of Defense for Acquisition, Technology and Logistics, February, 2004), Executive Summary, vii.

[16] Ibid, vii and 19.

[17] USAF Flight Plan 2047, 15.

[18] Ibid, 3.

[19] Ibid, 14.

[20]Harlan Geer and Christopher Bolkcom, *Unmanned Aerial Vehicles: Background and Issues for Congress,* (Washington, DC, Congressional Research Service, Updated November 21, 2005), Summary.

[21] Ibid, 9.

[22] USAF Flight Plan 2047, 68.

[23] Ibid, 17-18

[24] Ibid, 42-43

[25] Joint Publication 1-02, *DOD Dictionary of Military Terms* defines bandwidth as: The difference between the limiting frequencies of a continuous frequency band expressed in hertz (cycles per second). The term bandwidth is also loosely used to refer to the rate at which data can be transmitted over a given communications circuit. In the latter usage, bandwidth is usually expressed in either kilobits per second or megabits per second.

[26]Geer and Bolkcom, 2005, 21.

[27] U.S. Department of Defense, *Quadrennial Defense Review Report,* (Washington, DC: Department of Defense, February 6, 2006), 63.

[28] USAF Flight Plan 2047, 46.

[29] Geer and Bolkcom, 2005, 9.

[30] Joint Publication 1-02, *DOD Dictionary of Military Terms*, "Autonomous Operations".

[31] Dictionary.com Online definition: relating to or capable of speed equal to or exceeding five times the speed of sound.

[32] USAF Flight Plan 2047, 50.

[33] Joshua A. Sager, *UASs for the Operational Commander: Don't Ground MAV (Manned Aerial Vehicles)!*, Naval War College Research Paper (Newport, RI: Naval War College, May 4, 2009), 1.

[34] P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-first Century* (New York: The Penguin Press, 2009), 239.

[35] Unmanned Aircraft Systems Roadmap 2005-2030, Appendix F-Airspace, F-1.

[36] Kelly J. Haywurst et al, *Unmanned Aircraft Hazards and Their Implications for Regulation*, (NASA Langley Research Center, Hampton, Virginia, and Certification Services Inc., Eastsound, Washington, n.d.), 8.

[37]Unmanned Aircraft Systems Roadmap 2005-2030, 71.

[38] Joshua A. Sager, 9.

[39] Marc Kaufman and Dafna Linzer, "China Criticized for Anti-Satellite Missile Test," Washington Post, January 19, 2009.

[40] CBS News 60 Minutes, "Cyber War: Sabotaging the System", November 8, 2009, linked from CBS News.com, http://www.cbsnews.com/stories/2009/11/06/60minutes/ main5555565.shtml (accessed November 24, 2009).

[41] Geer and Bolkcom, 2005, 21.

[42] Giulio Douhet, *The Command of the Air,* trans. Dino Ferrari (1942; new imprint, Washington, D.C.: Office of the Air Force History, 1983), 30.

[43] Geer and Bolkcom, 2005, Summary.

[44]Unmanned Aircraft Systems Roadmap 2005-2030, Appendix A-Missions, A-5.

[45] Ibid, 52.

[46] Stephen G. Brooks and William C. Wohlforth, "Reshaping the World Order", Foreign Affairs, (March/April, 2009), in ProQuest (accessed 4 November, 2009).

[47] Joint Publication 1-02, *DOD Dictionary of Military Terms* defines Air Superiority as: That degree of dominance in the air battle of one force over another that permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.

[48] Bone and Bolkcom, 16.

[49] James Jinnette, "Unmanned Limits: Robotic Systems Can't Replace a Pilot's Gut Instinct", Armed Forces Journal Online, November 5, 2009, http://www.armedforcesjournal.com/2009/11/4302459 (accessed November 24, 2009).

[50] Michael L. Bartley, *Unmanned Combat Aerial Vehicles: A Close Air Support Alternative,* Professional Studies Paper (Maxwell, AL: Air War College Resident Program, December 9, 2002), 1.

[51] USAF Flight Plan 2047, 50.

[52] David Glade, *Unmanned Aerial Vehicles: Implications for Military Operations,* Occasional Paper No. 16 (Maxwell, AL: Air War College Center for Strategy and Technology, July, 2000), 23.

[53] James Jinnette

[54] U.S. Joint Chiefs of Staff, *Joint Publication 3-09.3: Close Air Support,* (Joint Chiefs of Staff, July 8, 2009), V-19.

[55] Joint Publication 3-09.3 describes Type 1 control as: used when the JTAC must visually acquire the attacking aircraft and the target for each attack. Analysis of attacking aircraft geometry is required to reduce the risk of the attack affecting friendly forces. Type 1 control is used when the visual acquisition of the attacking aircraft by the JTAC/FAC(A) and the analysis of attacking aircraft geometry is the best means available to reduce risk of the attack affecting friendly forces.

[56] Joint Publication 3-09.3: Close Air support, V-102.

[57] Joint Publication 1-02, *DOD Dictionary of Military Terms* defines Terminal Attack Control as: The authority to control the maneuver of and grant weapons release clearance to attacking aircraft.

[58] Joint Publication 3-09.3, ix.

[59] Kevin L. Digman, *Unmanned Aircraft Systems in a Forward Air Controller (Airborne) Role,* Research Report (Maxwell, AL: Air Command and Staff College, April, 2009), 11-13.

[60] Daniel Murray, "A Mid-Air with an Unmanned Aerial Vehicle is not a BASH Event*," Flying Safety Magazine*, December, 2006, http://findarticles.com/p/articles/mi_m0IBT/is_12_62/ai_n27100066/?tag=content;col1 (accessed November 13, 2009).

[61] Air Force Magazine.com, Online Journal of the Air Force Association, *Last Manned Aircraft?* May 18, 2009, http://www.airforce-magazine.com/DRArchive/Pages/2009/May%202009/May%2018%202009/LastMannedAircraft.aspx (accessed November 11, 2009).

[62] Joint Publication 1-02, *DOD Dictionary of Military Terms* defines Counter-Air as a mission that integrates offensive and defensive operations to attain and maintain a desired degree of air superiority. Counterair missions are designed to destroy or negate enemy aircraft and missiles, both before and after launch.

[63] U.S. Department of the Army, *The JOE 2009: Joint Operating Environment Update*, *"Challenges and Implications for the Future Joint Force",* Theater Strategy and Campaigning (Carlisle Barracks, PA: U.S. Department of the Army, December, 2009), 2-5.