

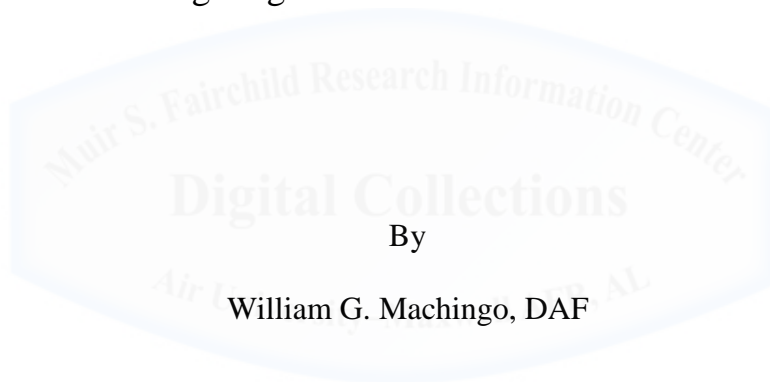
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AIR COMMAND AND STAFF COLLEGE

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Close Air Support (CAS) for Counterinsurgency (COIN) and
the Upward Trajectory of Unmanned Aircraft Systems (UAS):

Navigating the Undiscovered Domain.



By

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A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

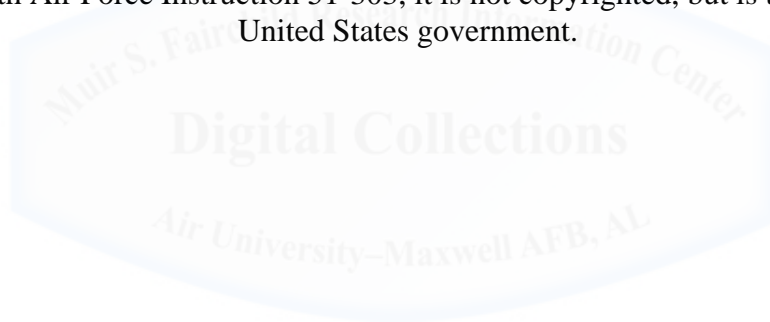
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Abstract

Future Counter Insurgency (COIN) mission environments will require both standard and non-standard close air support (CAS) systems that are reactive, accurate, timely, capable of long duration and survivable. An examination of current and near-term CAS assets, on the surface suggests UAS would appear to be excellent mission compatible substitutes or augmenters for CAS fixed and rotary wing assets in current COIN and Counter Terrorism (CT) operations.

Israeli military historian Martin Levi van Creveld's commenting on the current U.S. drone program indicated, "During the past decade, we have deployed our most skilled warriors and most advanced technology in an assassination program with few precedents in history. Result; the Middle East is in chaos and our foes have been revitalized. This resurgence, called the Darwinian Ratchet, is natural evolution working for our foes."¹ COIN or CT victory defined in FM-3-24, Insurgencies and Countering Insurgencies, remains highly unlikely until we overcome strict reliance on directives that fail to learn from experience or ignore the evolution of modern warfare.

Results and conclusions drawn from this research indicate that UAS augmenting fixed and rotary wing assets in the CAS role aligns better with the CT subset of COIN as described in FM-3-24. UAS can specifically be advantageous where SOFs can exploit the UAS's capabilities of being reactive, accurate, timely, capable of long duration and survivable, especially when used for killing individual insurgents and terrorist's while executing COIN and CT as outlined in FM 3-24.

Section I: Introduction

Research Question - Can combining standard and non-standard aviation assets enhance CAS effectiveness in a COIN environment?

Research Argument – Future Counter Insurgency (COIN) mission environments will require both standard and non-standard close air support (CAS) systems that are reactive, accurate, timely, capable of long duration and survivable. Joint Special Operations University’s (JSOU) Future Concept report indicates that “COIN conflicts consisting of non-state actors and insurgent organizations are envisioned as continuing to be a significant focus of future Special Operations Forces (SOF) missions.”² Figure 1 is a ranking by importance of the Joint SOF Education Azimuth Study findings displaying terrorism/counterterrorism (CT) and COIN, on a

Core Education Areas	Score
Terrorism/CT	5.4
COIN	5.4
UW	5.3
FID	5.0
Delib/Crisis Action PIng-Op	4.7
US-Conventional Interoperability & Integration	4.6
Information Ops	4.6
Coalition SOF Fundamentals	4.6
Key Government Agency Fundamentals	4.5
SO Theory, History, & Application	4.3

Figure 1 Reprinted from Joint Special Operations University, *Joint SOF Education Azimuth Questionnaire Results*, (February 2008)

scale of 0-6, as the highest priorities generated from over 340 interviews and questionnaires. Colonel Joseph D. Celeski (U.S. Army, Ret.), as a subset of COIN, believes the CT missions consisting of hunter-killer teams would benefit from being a standard part of SOF. Their employment rules of engagement (ROE) should be included in COIN doctrine, formally addressing maneuvers, fires and CAS requirements.³ Counterterrorism as defined in Joint Publication JP 3-07.2 *Joint Tactics, Techniques, and Procedures for Antiterrorism* “is offensive measures taken to prevent, deter, and respond to terrorism.”⁴ For decades, the U.S. Military focused primarily on force-on-force confrontations with

state actors. This single peer concept dates back to the Cold War when the Soviet Union was the only peer opponent, and has, highlighted a gap in force structure, training, and employment, requiring continuous refinement in response to the recent ever-changing Middle East insurgent and terrorist threats.

Therefore, in attempt to counter the rapid spread of radical Islamist ideology and coupled with U.S. disengagement from the Middle East, non-state actors such as Hezbollah, Al Qaeda, and now the Islamic State (ISIS), requires a reassessed CAS mission to support future COIN missions. Radical Islamist ideology has greatly amplified the complexity of COIN and CT warfare challenges, particularly for SOF and potentially all missions requiring CAS. In addition, the 2014 Quadrennial Defense Review (QDR) specified the requirement to rebalance COIN efforts for direct action, including intelligence, persistent surveillance, precision strike, and SOF.⁵ This position demonstrates an acknowledgement that CT is an important subset of the overall COIN mission. Michael J. Boyle is a lecturer in International Relations and a Research Fellow at the Centre for the Study of Terrorism and Political Violence at the University of St. Andrews. He says that contemporary American doctrine views CT as a strategy that "...relies on a combined package of air power, special forces, and the sophisticated use of intelligence to kill enemy operatives and disrupt terrorist networks."⁶ Contemporary COIN directives appear to be focused on the protection of the population by winning their 'hearts and minds' and killing the insurgent is secondary.⁷ Also identified in the QDR, SOFs have skill sets that specifically envisioned maintaining security and exploiting the element of surprise. These traits also align with the training that JSOU is providing and the employment of SOF for CT operations. Alternatively, more specifically, James Walsh writing for the Strategic Studies Institute (SSI),

says, “The U.S. military’s counterinsurgency doctrine stresses the importance of using force in a discriminate fashion so as not to alienate the local population.”⁸

Richard Sisk is a journalist having more than 40 years of experience embedded with U.S. troops. Sisk, in remarking on COIN’s required deep connection to the local population, suggests that the “clear, hold and build” strategy outlined in FM 3–24, *Insurgencies and Countering Insurgencies*, calls for individual soldiers and Marines to have the qualities of a modern-day “Lawrence’s of Arabia,” versed in languages and attuned to the culture and politics of the host nation.”⁹ To put COIN operations and techniques in perspective, COIN is not an overall strategic approach, but more of a situational strategy, addressing those situations that have a potential to have a strategic impact.

Overreliance on COIN as a strategic approach could have serious future detrimental effects. In a fictional accounting of the outcome of a future war, Charles Dunlap expanding on Sisk’s “Lawrence of Arabia” comments and highlighting the potential risks to U.S. security and the potential disastrous results of overemphasis on COIN and CT, writes what the victor may say, “They dramatically reduced strategic forces in favor of increasing the numbers of trendy “counterinsurgency” units. These were filled not with warriors specially trained for high-intensity combat but rather with a curious kind of “soldier” described in their counterinsurgency manual as one who “must be prepared to become ... a social worker, a civil engineer, a school teacher, a nurse, a boy scout.”¹⁰ Dunlap concludes his fictional account with a dire prediction of U.S. forces in future high-intensity combat, “As you know, we slaughtered these “boy scouts” by the thousands!”¹¹ Ironically, FM 3-24, was co-authored by then-Lt. Gen. David Petraeus of the Army and then-Lt. Gen. James Amos, of the Marine Corps, two of the key figures associated with the COIN strategy currently employed in Afghanistan, Iraq and to some degree in Syria.

Many believe that as Unmanned Aircraft Systems (UAS) technology matures, the requirement for manned missions dedicated to CAS may be reduced or in some circumstances be eliminated, but at the same time fail to recognize that the rebalance and integration of assets for CAS must consider more than the minimization of U.S. casualties or sortie costs in the decision process.

On the surface, UAS would appear to be mission-compatible substitutes or augmenters for CAS fixed and rotary wing assets in current COIN and CT operations. Douglas C. Lovelace JR., Director Strategic Studies Institute and U.S. Army War College Press wrote the forward to James Walsh's *The Effectiveness of Drone Strikes in Counterinsurgency and Counterterrorism Campaigns* concerning the UAS usage for COIN and CT. Lovelace writes, "While drones have the capability to punish and deter insurgent organizations, they do not contribute alone to the establishment of effective state authority in direct and meaningful ways, which likely requires large numbers of ground forces and civilians to provide services to and gain intelligence from the local population."¹² UAS augmenting fixed and rotary wing assets in the CAS role appears better aligned to the CT subset of COIN. UAS integration can specifically be advantageous where SOFs can exploit the UAS's capabilities to be reactive, accurate, timely, capable of long duration and survivable especially when used for killing of insurgents and terrorist's when executing COIN and CT as outlined in FM 3-24.

Section II: Background

For those missions that still require manned missions, we need to think hard about whether we have the right platforms—whether, for example, low-cost, low-tech alternatives exist to do basic reconnaissance and close air support in an environment where we have total control of the skies—aircraft that our partners also can afford.

Secretary Of Defense Robert Gates, Maxwell AFB, 21 April 2008

JP 3-26, Counterterrorism, 13 November 2009, unintentionally provides the terrorist or insurgent with the perfect counter strategy to U.S. COIN efforts. The following statement (of JP 3-26 qualifications) could be directly from an insurgent's strategy documentation, "U.S. superiority in conventional warfighting drives many of our adversaries to avoid direct military confrontation with the United States. Irregular Warfare (IW), and especially the employment of terrorist tactics, has become the warfare of choice for some state and non-state adversaries. They employ a strategy of physical, economic, and psychological subversion and attrition to undermine, erode, and ultimately exhaust the national power, influence, and will of the United States and its strategic partners."¹³ The October 2014 edition of JP3-26 edited from the 2009 edition does not include the previous quote. Suicide bombs and bombers, beheadings, Improvised Explosive Devices (IEDs) have all had significant physical and psychological effects on the prosecution of the overall US COIN and CT strategy.

Insurgents and terrorists have also realized that the exploitation of the significant effect time has on the potential success of COIN, which is yet another powerful counter to US military power. The success of any COIN remains in serious jeopardy as long as insurgents or terrorists are supported by the Host Nation (HN) population and granted 'safe havens', allowing them to rebuild and redeploy in a seemingly infinite cycle.

Army Lt. General Keith Walker, Deputy Commander of the Army's Training and Doctrine Command indicated, "...that the debates on COIN and how it was used were intellectual exercises with little value as the military prepares for future challenges. Things really are different as we come out of Iraq and Afghanistan,"¹⁴ Current COIN philosophy requires major investments in time and money as paramount to the overall success. JP 3-26 also acknowledges that the insurgents and terrorists effectively employ a strategy that calls for fighting and then blending into the HN population. The most significant impact from this blending severely inhibits COIN's use of conventional military power (airpower) to accomplish its key mission: isolating insurgents and terrorists from the HN population.

Another recent tactic of the insurgents and terrorists specifically exploits the digital interconnectivity for news and propaganda worldwide when countering U.S. air strikes. Insurgents have become adept at using the media as a conduit to imply that somehow American UAS actions violate international laws. James Walsh in his report, *The Effectiveness of Drone Strikes in Counterinsurgency and Counterterrorism Campaigns* says, "A recent drone campaign involves the use of force against militants in safe havens in Pakistan, but the United States is not at war with Pakistan. Even if the drone strikes only kill bona fide militants, these individuals may not be, at the time of their deaths, always involved in direct combat with the United States in Afghanistan. Therefore, it is plausible to describe drone strikes as violating the prohibition of international human rights law against extra-judicial killings. From this perspective, any civilian deaths caused by drones are unacceptable."¹⁵ This digital interconnectivity also permits the insurgents and terrorists unlimited access to the hearts and minds of the HN population, as well as to the population of the nation supplying the COIN and CT forces.

Major Adam Palmer, in his research entitled, *Autonomous UAS: A Partial Solution to America's Future Airpower Needs* addresses the use of UASs and notes, "America's air operations in Iraq and Afghanistan have been vilified for causing civilian casualties. These civilian casualties are normally due to the difficulty of discerning between civilians and insurgents when no participants wear uniforms. Thus, UAS will have limited capabilities to conduct close-air support and counterinsurgency missions. In these missions, the USAF will need to retain some capability to conduct Man in the Loop (MITL) operations, or will need to retain MITL UAS or manned platforms."¹⁶ The difficulty of discerning between civilians and insurgents applies to all CAS platforms, not just the UAS. As an example of the legal implications regarding UAS strikes, Palmer highlights, "...a recent Freedom of Information Act (FOIA) request by the American Civil Liberties Union (ACLU) labeled *U.S. UAS operations in Pakistan as 'targeted killing program(s)'* whose parameters are 'almost entirely obscure' from public scrutiny."¹⁷ Since the Law of Armed Conflict (LOAC) is neither absolute nor binding for insurgents, the limits of acceptable wartime conduct, also known as Jus in Bello, or international humanitarian law, the insurgent interprets it in such a way as to pit the media against the U.S. military. This court of public opinion is an effective weapon to counter UAS strikes. As a recent example of that strategic effectiveness, on 3 October 2015, a U.S. Precision Guided Munition (PGM) struck a hospital in Kunduz Afghanistan. This accident resulted in an official Presidential apology to the administrators of the hospital, the Afghan people, and Afghan government. Kristen Holmes, CNN White House Producer reported, "The President assured Dr. Liu that the Department of Defense investigation currently under way would provide a transparent, thorough and objective accounting of the facts and circumstances of the incident

and, if necessary, the President would implement changes that would make tragedies like this one less likely to occur in the future."¹⁸

FM 3-24 is the definitive guidance for successful execution of U.S. COIN operations. In light of increased media exposure and subsequent political pressure, its guidance has become subject to varying interpretations. Subsequent ROEs drafted and put in place, while intended to protect HN civilian populations, now require that significant risks to safety and success be upon the COIN and CT forces. Fred Kaplan, author of *The Insurgents: David Petraeus and the Plot to Change the American Way of War* and *1959: The Year Everything Changed*, says that, "The COIN advocates argue that only through their approach can al-Qaida and the Taliban be defeated. Hunting and killing terrorists has its place, but in the long run it only gives the enemy the initiative, lets them melt away into the landscape, and does little to stop new recruits from taking their place. The best way to keep al-Qaida at bay is to dry up its support by earning the trust of the civilian population, building roads, creating jobs, and striking power-sharing deals with tribal elders."¹⁹ Kaplan also presents the opposite perspective regarding COIN explaining "...a targeted CT campaign, its advocates say, would at least demonstrate the West's resolve in the war on terrorism and keep al-Qaida jihadists contained. It's a type of fighting that we know how to do, and its effects are measurable."²⁰ Many of these "targeted" CT air strikes carried out against individual insurgent and terrorist leaders occurred in places such as Afghanistan, Pakistan, Iraq, Yemen, etc.

Over recent years there has been much debate centering on the overall strategies of COIN and CT and the desired outcomes. While these types of missions may represent much of the direct combat experience for the near future, Gary Anderson, retired Marine Colonel and former State Department employee, provides an interesting civilian perspective, explaining; "The

counterterrorism school worries that the Army will lose its ability to fight conventional battles if it concentrates on counterinsurgency. However, this need not be a zero sum game. Many years ago, the Marine Corps told the nation that it was not too proud to do windows, but the Marines are much smaller than the U.S. Army; the Army needs the same philosophy, but faces a much more complex problem. We need an Army that can whip China or Iran in a conventional war, if necessary, and also do windows.”²¹

Airpower and its use for CAS has been a major force-multiplier ever since the introduction of the airplane in World War I. CAS, whether employed for COIN, CT, or as part of an all-out total war, requires routine reevaluation of asset mix, capabilities, and ROEs to ensure that U.S. military superiority never erodes or presents a challenge. As recently as 24 April 2015, Murry, et al. analyzed CAS for the Army Capabilities Integration Center (ARCIC) and highlighted some of the beneficial effects CAS can have on the modern battlefield. They stated, “Not only does close air support provide physical advantages to friendly forces, it also provides them with the psychological advantage of knowing that, upon contact with elusive and capable enemies, airpower will pose enemy forces with multiple dilemmas and force them to respond to multiple forms of contact.”²² They go on further to describe the optimum focus of CAS, “The nexus of CAS is at the tactical formation while in close contact with the enemy.”²³ As the insurgents continuously modify their tactics to become more elusive, the successful employment of CAS depends heavily on aircraft that are reactive, accurate, timely, capable of long duration and survivable. Improved CAS integration along with the development of a more CT centric strategy for SOF can be an effective counter to the ever-changing insurgent/terrorist threats in the near future.

Section III: What is CAS

What is CAS? – Writing for *Breaking Defense*, in March 2015, Colin Clark, while attending the Air Force-sponsored week-long CAS Summit presents a description of CAS, “CAS is the act of using aircraft to kill the enemy when he gets close to our troops. It requires superior communications, spectacular accuracy, fabulous flying and great care on the part of the Joint Terminal Attack Controller (JTAC) who provides the plane, in this case the UAS with targeting information.”²⁴ As the insurgents continue to modify their tactics to counter increasing CAS effectiveness, the future of CAS will continue to require aircraft that are reactive, accurate, timely, capable of long duration and survivable. With the widespread fielding of precision-guided munitions (PGMs), CAS employment accuracy and lethality has improved significantly. This increased accuracy has allowed for the expansion of the CAS mission to those aircraft not traditionally associated with CAS, such as the Army AH-64 Apache and Air Force A-10. An example of the impact of PGMs, the 250-lb. Small-Diameter Bomb (SDB) successfully



Figure 2 Small Diameter Bomb Increment I (SDB I)
(Reprinted from Boeing Backgrounder Publication January 2012)

integrated onto non-traditional CAS assets such as the F-15E, F-16C/D, and F-22. The SDB, while initially envisioned as a long-distance glide bomb, was also well suited for adaptation to direct attack. Figure 2 is an artist rendering of the Boeing SDB, as it would appear in flight. The SDB was a new weapon, allowing it to be easily adapted to the COIN mandate in FM 3-24 to protect

the HN civilian population against collateral damage. Further mitigating collateral damage, “...the SDB Focused Lethality Munition (FLM) variant incorporates a carbon fiber composite warhead case and an advanced multiphase blast explosive for precision engagements with ultralow collateral damage outside the blast zone.”²⁵ The FLM is a direct result of the insurgent’s tactic of hiding in urban locations where traditional blast munitions would result in increased collateral damage. The standard 500lb MK-82 Iron Bomb Body, in service since Vietnam, was fitted with the Raytheon Paveway™ II guidance kit. The assembled bomb in



Figure 3 Raytheon Paveway Laser Guided Bomb (Reprinted from Raytheon Corporation website <http://www.raytheon.com/capabilities/products/paveway/>)

Figure 3 represents one possible configuration of the Guided Bomb Unit (GBU) 12 series of PGMs. The Paveway™ II guidance kit is simply a bolt-on nose-mounted laser seeker and rear fins for guidance. These two examples of PGMs demonstrate that new high-tech munitions and the relatively simple modifications to current assets are both viable and cost

effective methods to fielding PGMs. Lt. Col. Derek O’Malley, an Air Force F-16 and F-35 pilot, and former USAF Weapons School instructor, writing for *War on the Rocks*, also attended the CAS Summit. He attributed the following to an unnamed Army officer defining CAS as, “Look, I don’t care how you do it, or what you do it with — I just need you to find the bad guys that are shooting at me, kill them quickly, don’t hurt or kill me, and help me find more bad guys before they shoot at me!”²⁶ A review of the historical uses of air power provides some of the fundamental capabilities associated with CAS, which are, “...effective close air support loiters

overhead during sustained operations, delivers time-sensitive information to identify enemy locations, and delivers critical ordnance to the point of need for ground-force commanders.”²⁷

The requirement for CAS assets to loiter found in JP 3-26, Counterterrorism, is in response to the insurgents and terrorists who effectively employ a strategy of fighting and then disappearing into the HN population. If CAS is to have the capability to improve the potential of “victory” for COIN, it must depend heavily on aircraft that are reactive, accurate, timely, and capable of long duration. O’Malley’s article, *The Future of Close Air Support*, also addresses the same terrorist tactic of blending in or disappearing into the HN population saying, “Persistence of CAS becomes particularly important when enemies do not operate in the open in large formations (an increasingly likely scenario). To counter America’s considerable precision strike capabilities, enemies will often concentrate forces at the time of assault and melt away afterwards. Methodical and persistent sensor coverage is imperative to find, fix, and kill an elusive enemy.... However, persistence and loiter time will be a challenge for all of our current CAS-capable aircraft.”²⁸ O’Malley compared the capabilities of the A-10 and F-35 in his article that specifically left out the UAS as a CAS-capable aircraft. Enhanced integrated and coordinated CAS can be especially effective against enemy personnel when the combination of ground units, airpower, and fires are employed all having the intent of destroying insurgent and terrorist personnel, organizations, and ‘safe havens’.

Section IV: Description of Problem and Key Issues

A change in CAS ROEs and employment tactics are necessary to improve the likelihoods of “success” of current and future COIN or CT missions. What appears as a solid prospect to crush insurgents and terrorists alike, but extremely difficult to employ under current COIN ROEs, is simply killing them where and when they are found. This would apply to killing the personnel who used a weapon and dropped it, blended into the HN population, and then hunting them and their supporters back to their bases of rest, relaxation, and recovery, or “safe zones”.

Antulio J. Echevarria II, in his report for the Strategic Studies Institute, postulates that these neighboring ‘safe zones’ more closely align with the original intent of a Clausewitzian center of gravity (COG) instead of its modern interpretation. Echevarria believes Clausewitz’s original COG definition is more physics based and says, “...in fact, it’s not a source of strength or a critical capability, but a focal point that is essentially effects-based, rather than capabilities-based.”²⁹ While the COG definition argument supports both sides, these zones by themselves are not a COG. Applying Clausewitz’s original intent to ‘safe zones’ they have the effect of providing a seeming endless supply of fighters. Applying the modern Clausewitzian interpretation from JP 5-0, Joint Operation Planning, the source of strength and morality seems to be religion.³⁰ Regardless of COG interpretation used, these ‘safe zones’ would then be the focus of CT, SOF and associated CAS activities when operations outside the HN borders are approved.

Often these safe zones used by insurgents are located in neighboring countries, which then poses special geopolitical issues not addressed as part of CAS optimization for COIN conclusions and recommendations of this research. This research assumes that political impediments have been resolved sanctioning CT and CAS operations outside of the HN.

Jason Rineheart is an editor and contributor for The Terrorism Research Initiative. In his article, *Counterterrorism and Counterinsurgency*, he suggests that, "It may be more useful from a counterterrorism perspective to view terrorists as rational actors who adopt the tactic of terrorism as a strategic choice to pursue political objectives, not as passive observers who are susceptible to what the supposed underlying cause forces them to do."³¹ Thus, by identifying Al Qaeda, the Islamic State (ISIS) and any group of insurgents as an entity, their modern Clausewitzian definition of a COG would be Radical Islam itself. The definition of a COG in the *DOD Dictionary of Military and Associated Terms* is "...the source of power that provides moral or physical strength, freedom of action, or will to act."³² This is in some ways similar to the traits espoused by various religions. Associating the concepts of morality, strength of purpose, and will specifically to Radical Islam, these traits provides a common binding theme that is "...intertwined in the socioeconomic, political and religious fabric of Muslims living in at least 80 countries."³³ The COG suddenly becomes astronomical in size and complexity.

FM 3-24, *Counterinsurgency* states that "...a COIN victory happens when the people no longer support the insurgency (actively or passively), but rather support their government. The problem with an occupying army attempting to successfully employ COIN is that a "foreign invader" is trying to win the locals' support, and not the homeland army/government."³⁴ Within the Muslim-controlled lands of the Middle East, beliefs and interpretations within Islam itself suggest that U.S. forces, or any non-Muslin force, will viewed as a Foreign Invader, Infidel and Crusader. Radical Islam ties all these insurgents together for a common aim, jihad, while Islam in general has the effect of focusing HN Muslim population attitudes, in the favor of the insurgent instead of the foreign force.

ROEs for CAS employment for COIN have been evolving since Operation Enduring Freedom (OEF) began in 2001 starting with a very restrictive set of rules. Benjamin S. Lambeth of the Rand Corporation in his work, *Air Power Against Terror: America's Conduct of Operation Enduring Freedom*, wrote, "As the Pentagon and the United States Central Command (CENTCOM) translated the Commander in Chief's guidance into its most restrictive interpretation, the restraints emplaced were so stringent they likely reduced the chance of success. Rules stipulated that targets classified as significant, that could cause a collateral damage incident, had to be approved by either CENTCOM or Washington and could not be approved by the Air Component Commander."³⁵ By taking the risk adverse position of making collateral damage a key decision factor in airpower employment, the net effect placed a massive impediment directly in the path of the FM 3-24 definition of victory for COIN or CT.

In Afghanistan in 2009, the newly published restrictions in the use of CAS have hampered the way the International Security Assistance Force (ISAF) executed the COIN mission. General McChrystal, the ISAF Commander, released his new interpretation of FM 3-24 on 6 July 2009. His interpretation, presented in a Tactical Directive Memorandum (TDM), placed major emphasis on protecting civilians vice killing insurgents. The guidance also directed commanders to be more thoughtful when calling in air strikes.³⁶ The strict restrictions placed on the employment of air-to-ground munitions and indirect fires against residential compounds had the unintended effect of, in some cases, eliminating the use of air strikes altogether. However, an exception existed for self-defense. A unit was authorized to use air strikes as a last resort to effectively counter the threat, which allowed commanders the ability to protect their troops' lives" as a matter of self-defense.³⁷ Additionally, ISAF forces were not entering or firing into a mosque or any religious or historical site except in self-defense.³⁸ These restrictions had the

unintended consequence of providing the insurgent a “safe haven” from which to attack ISAF forces without retaliation.

Reviewing the TDM’s effectiveness, the constrained use of air strikes in Afghanistan also had the effect of placing ISAF forces at greater personal risk while providing little benefit to the Afghan people. Despite this induced risk, this approach, protect the HN population, is still the ideal way to fight an insurgency. Major Damien Mason, whose thesis reviewed and supported the outcome of OEF, said that, “Operational level commanders have to balance the removal of a kinetic tool from their forces, against winning the support of the Afghan people. For a counterinsurgency, General McChrystal decided correctly.”³⁹ The guiding principle in the TDM declares that the HN population is the COG for COIN and places the safety of the population above any goal to kill or destroy the insurgency. Focusing on the HN population is only half of the solution. Without vigorous prosecution of the insurgent COIN has no chance of success.

Sean Naylor in his article in Defense One, *Inside the Pentagon’s Manhunting Machine, A brief history of Joint Special Operations Command, from Panama to the war on terror*, ironically points out, the kinetic tools effectively banned by the TDM were the tools of choice when “...in 2006 General McChrystal, then head of JSOC, specifically tracked and killed Abu Musab al-Zarqawi. At 6:12 p.m., an F-16 dropped a laser-guided 500-pound bomb on the house and followed it less than two minutes later with another bomb. The house disintegrated.”⁴⁰ The photo in Figure 4 is the remains of the al-Zarqawi safe house after a successful PGM strike in 2006. Any of the aircraft in Figure 5 could have made that strike, including the F-35, which isn’t operational at this time. Naylor goes on to write, “Although JSOC seemed to have eviscerated al-Qaeda in Iraq by the time the United States pulled out of Iraq at the end of 2011, it had not completely destroyed it. Over the next

three years, al-Qaeda in Iraq evolved into the Islamic State, which, after establishing a safe haven in



Figure 4 Zarqawi's safe house—after GBU-12 attack, reprinted from <http://sofrep.com/38297/how-abu-musab-al-zarqawi-really-met-his-fate/>

war-torn Syria, swept across northern Iraq in 2014, seizing town after town from which JSOC and other U.S. forces had evicted al-Qaeda in Iraq at great cost several years earlier.”⁴¹

Martin Levi van Creveld, Israeli military historian and theorist, in his 28 May 2015 article for the Fabius Maximus website, a multi-author website about geopolitics from an American perspective. Martin van Creveld describes the emergence of ISIS, by referencing David Anthony Durham's novel *Pride of Carthage*, suggesting that a general during the Second Punic War could have made a similar comment as stated by Naylor above. Durham suggests that a General may have stated something similar to this, “I've killed them by the tens of thousands, scoured their countryside at will, pried their allies away, and humiliated them day after day. I have burned their crops and looted their wealth. I have sent a whole generation of their generals into the

afterworld ... Have I changed nothing? They are stronger now than before. They are more than before. They fight more sensibly than before. They win when they used to lose.”⁴²

The last five statements of Durham’s quote, word-for-word, can be a direct inference to al-Qaeda and its resurgence as ISIS. For there to be a reasonable chance of “victory” in COIN as defined in FM 3-24, CAS must be in a state of continual evolution combining fixed wing, rotary wing and UAS assets. Altering tactics due in part to, enemy countermeasures in urban and sensitive areas will degrade the COIN force’s ability to target the enemy with standoff PGMs. A Joint Terminal Attack Controller (JTAC) talking to a pilot on the radio and directing weapon employment on a specific target does not automatically make it CAS. For current and future COIN to be effective, SOF will be required to be “danger close” to pinpoint specific targets for PGMs, to minimize collateral damage required by COIN doctrine and published ROEs.

For any airborne CAS asset, survivability results mainly from not incurring aircraft structural damage in the first place. Therefore, survivability is a key component to this mission. The proliferation of advanced air defense systems including Man Portable Air Defense System (MANPADS) has further necessitated a re-evaluation or re-optimization of CAS assets and tactics. CAS also has inherent advantages and disadvantages. The primary advantage is that significant firepower, dropped within close proximity to friendly forces, can destroy an enemy in direct combat with those friendly forces. CAS is a direct extension of the ground force. Murray et al, in their report, *Close Air Support: An Essential Element to Joint Combined Arms Operations* says that: “Effective CAS against elusive and capable enemies will depend on aircraft performance and munitions capabilities as well as ground forces' ability to accurately

locate targets.”⁴³ Or in other words, the five principles of Dynamic Targeting, fix, track, target, engage, and assess (F2T2EA) are key facilitators to effective CAS.

Fixed Wing CAS Capability/Effectiveness

Fundamentally, CAS missions involve using aircraft to attack targets on the ground. CAS has matured during the course of World War II and has played an important role in most major conflicts since. Primarily, the role of CAS is to pin down an enemy or deter an attack on overwhelmed friendly forces with strafing and bombing runs.

U.S. Air Force Close Air Support Aircraft and Munitions										
										
	A-10	AC-130W ¹	B-1	B-52	F-15E	F-16 Block 40/50	F-22	MQ-1 Predator	MQ-9 Reaper	F-35A ²
MUNITIONS										
GBU-10 2,000-lb. laser-guided Paveway II	✓		✓	✓	✓	✓				
GBU-12 500-lb. laser-guided Paveway II	✓		✓	✓	✓	✓		✓	✓	✓
GBU-24 2,000-lb. laser-guided Paveway III					✓	✓				
GBU-28 5,000-lb. bunker buster				✓	✓					
GBU-31 2,000-lb JDAM	✓		✓	✓		✓				✓
GBU-32 1,000-lb. JDAM			✓	✓		✓	✓			✓
GBU-38 500-lb. JDAM	✓		✓	✓	✓	✓			✓	
GBU-39 250-lb. Small-Diameter Bomb		✓			✓	✓	✓			
GBU-49 500-lb. Enhanced Paveway II				✓					✓	
GBU-54 500-lb. laser JDAM	✓		✓		✓	✓				
Cannon	✓	✓			✓	✓				✓
OPERATING COST PER FLIGHT HOUR (fiscal 2012)	\$17,398	\$28,455	\$54,218	\$67,475	\$37,504	\$22,954	\$62,106	\$4,403	\$3,976	---

¹OCPFH for AC-130H = \$31,338, AC-130U = \$46,138 ²OCPFH for F-35A is December 2013 SAR Projection, inflated from fiscal 2012 to fiscal 2013 dollars, NET December 2016 in service Source: U.S. Air Force

Figure 5 U.S. Air Force CAS Aircraft and Munitions, Source: U.S. Air Force

COIN, Hybrid and asymmetric warfare have evolved to become the new normal in modern warfare. Modern U.S. fighters can bring significant force to bear when they are over the battlefield. With their increased speed, visual observation is more difficult. This high-speed, a lifesaver in dogfights, translates into very short loiter times. Figure 5 tabulates PGMs used for CAS by aircraft type.

Major Roberto Scott USMC, in his thesis *CAS – A Turboprop Solution for the COIN Fight*, highlights a problem encountered by pilots of high-speed fixed wing fighters. He emphasizes the difficulty that a Forward Air Control (FAC) or JTAC has orientating the pilot towards the target citing from a CRS Report to Congress: “Modern FW aircraft are incredibly fast and have a hard time acquiring targets in complex type I, II, and III environments.”⁴⁴ Scott also cites a report by USMC Lessons Learned Center, *Urban Close Air Support (Urban CAS)* supporting the CRS report: “...of the many lessons identified from CAS engagements in OIP and OEF identifying the target to the pilot proved to be one of the most difficult links in the kill chain.”⁴⁵ Scott continues, “One current method to facilitate this communication is the Remotely Operated Video Enhanced Receiver (ROVER) system, but the equipment is cumbersome and delicate.”⁴⁶ Joint Publication 3-09.3 Close Air Support, provides the following definition of the three types of environments FACs and JTACs operate:

Type 1, accomplished by visually acquiring the attacking aircraft, assessing the attack geometry and maintaining control of individual attacks;

Type 2, accomplished by paying particular attention to other measures in place to reduce risk and maintaining control of individual attacks;

Type 3, accomplished by paying particular attention to other measures in place to reduce risk and the measures in place allowing for multiple attacks within a single engagement.⁴⁷

Typically, in a dogfight, for which a fighter’s design optimizes, faster is better. However, modern COIN experience is demonstrating that speed for CAS missions can become a liability. Michael Fabey, in his article *Counter-Insurgency Urgency*, wrote, “...the Air Force historically has modified high-tech jet fighters or bombers for COIN operations instead of investing in a counter-insurgency fleet, which would consist of lower, slower flying turboprop aircraft for fixed-wing needs.”⁴⁸

Accepted logic is true to a certain extent; that faster aircraft are more survivable and that slower aircraft offset the velocity advantage with improves pilot situational awareness, lower

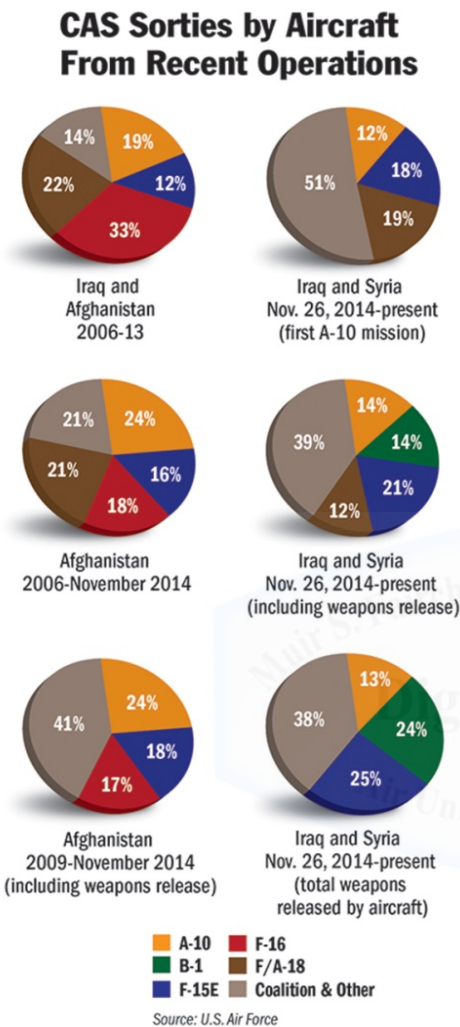


Fig. 6 CAS Sorties by Aircraft, Source U.S. Air Force

cost, and longer loiter time.⁴⁹

FW assets project significant firepower and lethality for CAS or any ground fight. Figure 6 shows FW assets used for CAS for COIN and CT missions. When bombing specifically for strategic effect or interdiction missions behind lines of contact, Lt Col Caleb M Nimmo in his research, *Bypass Ratio: The US Air Force and Light-Attack Aviation* noted, "...when the enemy is farther away from friendlies, jet aircraft such as the F-16 have the advantage of carrying larger ordnance."⁵⁰ PGMs have mitigated much of the difficulty of pilots having eyes-on the target, since these weapons guide by illumination or fly to a pre-determined set of Global Positioning System (GPS) coordinates. The FW asset's high speed also allows them to be on ready alert; thus,

when called, transit times to the battlefield are relatively short. Therefore,

CAS responsibilities have easily expanded to include the F-15 and F-16. Richard Mesic et al, in the Rand Report: Project Air Force, *Courses of Action for Enhancing USAF "Irregular Warfare" Capabilities, A Functional Solutions Analysis*; this expansion is due in part "...in recent operations, U.S. aircraft have enjoyed near impunity flying at medium to high altitude, above the reach of ubiquitous low-level threats ranging from man-portable air-defense missiles



Figure 7 USMC F/A-18D with damaged turkey feathers after being hit by a MANPAD during Operation Desert Shield. Reprinted from <http://armyphotos.net/>

(MANPADS) to cannons. Flying against more-sophisticated radar-guided air-defense missiles, U.S. forces would have to employ stealthy aircraft and standoff weapons.”⁵¹ Figure 7 is an example of a damaged USMC F/A-18D caused by a MANPAD during Operation Desert Shield.

When the airspace in which FW assets are employing CAS is

contested, loiter times will be significantly reduced in the tradeoff for speed of entry and exit of the battlefield. To be successful as CAS assets, FW aircraft must demonstrate the characteristics of being reactive, accurate, timely, capable of long duration and survivable. Therefore, ground commanders require USAF assets to be as effective as possible when providing CAS support. Mesic also addresses aircraft structural life limitations imparted by CAS missions. “There is also increasing concern over efficiency, —e.g., that expensive USAF platforms such as the F-16 are being used in CAS and non-traditional ISR (NTISR) missions (thereby “burning out” aircraft much faster than intended, with severe consequences in future years) that perhaps could be conducted better (more efficiently and with less cost) by other types of manned or unmanned platforms.”⁵²

Rotary Wing CAS Capability/Effectiveness

Modern attack helicopters execute the CAS mission with various standoff weapons. RW assets are slow moving and susceptible to MANPADS and small arms fire, and attack helicopters used for CAS are primarily in a medium or low threat environment where enemy air defenses are weak or not present at all. Andrew S. Groenke, in his research “*CAS, Interdiction, and Attack Helicopters*” provides the following scenario in a medium or low-level threat environment. Groenke says, “The Apache AH-64 is watching its surroundings with Forward Looking Infrared (FLIR), and then as soon as a missile is launched in its direction, the Apache, knows and will use its infrared countermeasures such as flares or other active systems it has to try to divert a missile. Worst comes to worst it gets hit and takes damage, but the Apache depending on where it gets hit exactly and how bad the damage is, might still be able to get away because of its armor. With the introduction of first armed and then dedicated attack helicopters there was a seemingly natural expansion of ideas for using these aircraft as interdiction and CAS platforms.”⁵³

Attack helicopters’ two primary missions are Interdiction and CAS. The main difference between them is location. Interdiction often occurs behind the front lines and CAS is within close proximity to friendly forces. Groenke also points out that the missions of the attack helicopters are limited because “...attack helicopters lack weapons with the destructive force to destroy bridges or other similar transportation infrastructure, prevention usually involves destroying the material and personnel themselves.”⁵⁴ A logical assumption then would be that destroying material and personnel occurs at the tactical level on the battlefield. Whereas, interdiction missions better suited to FW assets occurs at the operational level well behind the battlefield.

Groenke believes that the evolutionary development of attack helicopters indicates that, “Attack helicopters were introduced as a way of compensating for a perceived lack of CAS as supplied by the Air Force.”⁵⁵ In 1962, in response to this perception, at the direct request of Secretary of Defense Robert McNamara, The Rand Corporation filed a report titled, *U.S. Army Tactical Mobility Requirements Board* (the Howze Board) to review and test new concepts integrating helicopters into the United States Army. The report stated, “...dedicated attack helicopters were included in these proposals in spite of the fact that, by agreement, the Air Force was responsible for supplying CAS to Army forces. In an even greater poke in the eye for the Air Force, there was a recommendation to convert light fixed-wing observation aircraft into CAS aircraft.”⁵⁶ Groenke concludes his research with “...in addition to possessing unique capabilities, the attack helicopter performance is limited against a thinking, adaptive enemy.”⁵⁷ Still, to be successful as a CAS asset, RW aircraft must also demonstrate the characteristics of being reactive, accurate, timely, capable of long duration and survivable. The attack helicopter’s fundamental weakness is survivability against MANPADs and small arms fire. Integration with ground maneuvering forces, such as the Army and Marines, to some extent could mitigate this issue.

Groenke’s research recommends that attack helicopters, by leveraging the following factors, “More responsive Suppression of Enemy Air Defenses (SEAD), also known as "Wild Weasel" and "Iron Hand" operations in the United States, reasonably safe areas for loitering, and improvements in survivability equipment have allowed the attack helicopter to continue as a successful CAS platform across a range of conflict.”⁵⁸

RW aircraft, when assessed against the desired capabilities for CAS, reactive, accurate, timely, capable of long duration and survivable exhibit specific limitations that must be

incorporated into any deployment plans. Major Adam Pastor's research, entitled *Helicopters in Irregular Warfare: Capabilities, Challenges, and Missed Opportunities*, identifies some of the specific limitations of RW aircraft. Pastor writes, "Limitations include the speed, range, and lifting ability in terms of passenger/cargo weight, cubic feet available internally, and the external load-bearing capability. Additionally, the environment can cause significant limitations, such as poor weather conditions, extremes in temperature, and high altitudes that reduce the power produced by the engines and the lift produced by the rotor blades."⁵⁹ RW aircraft's ability to move low and slow also makes them highly susceptible to MANPADS, RPGs and small arms fire. This limitation in survivability necessitates that attack helicopters used for CAS operate in a medium or low threat environment where enemy air defenses are weak or not present at all.

UAS CAS Capability/Effectiveness

Groenke's research, while focusing on attack helicopters for CAS, also accepted the Unmanned Aerial Vehicle (UAV) as a potential CAS asset. Since his research submission in June 2005, the term UAV has been superseded by the term UAS. Groenke says, "The future for interdiction and CAS almost certainly includes the use of armed UAVs capable of providing significant fire support. UAVs adapted for this purpose are already operational and both the U.S. Army and Marine Corps are working on doctrine that will employ these systems alone and in concert with other aircraft, including attack helicopters. Nonetheless, armed UAVs have at least operated in very close proximity to ground forces, even if they have not provided outright CAS in recent conflicts."⁶⁰ It has been 10 years since Groenke made his prediction concerning UAVs and a February 2015 article in *Defense One* appears to have confirmed his assessment.

Patrick Tucker, Technology Editor for *Defense One* in his article *The Air Force Wants To Make Its Drones Smarter and Deadlier* discusses on the outcome of a recent Air Force Advisory Board study. He explains, “In June, the Air Force Scientific Advisory Board completed a study (the first of three) that suggested the Air Force could modify the Reaper to be at least somewhat useful against a well-defended enemy. To prepare the Reaper for tougher fights, the committee recommended giving it a radar warning receiver and other improvements for situational

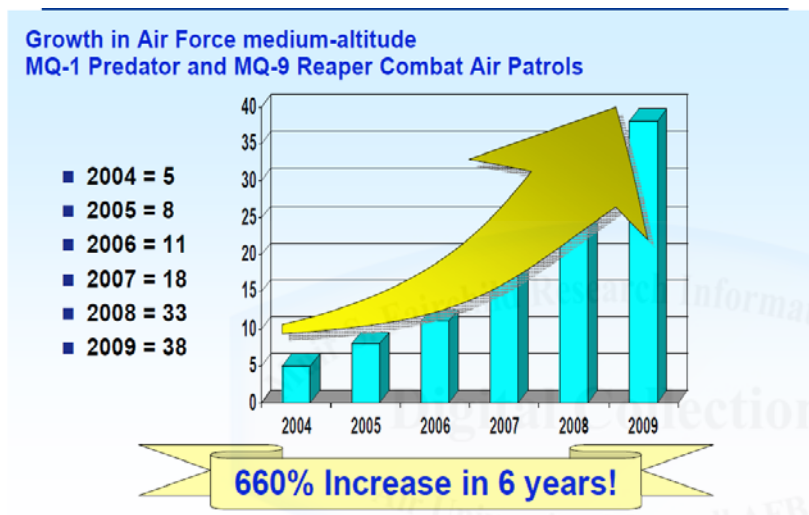


Fig. 8 Expansion of UAS Combat Air Patrols (CAP) s Air Force Report, *Source* U.S. Air Force

quoted in the February 6, 2015 edition of *Air Force Times* said, “The Air Force's fiscal 2016 budget would fund 60 MQ-9 combat air patrols in a 24-hour period, an increase from 55,”⁶² which represents almost a 60% increase from 38 CAPs in 2009.

In a June Air Force report on the future of drone autonomy, Mica Endsley, the Air Force’s Chief Scientist, suggested that, “...greater autonomy can change the game only if the operator still has all the possible information needed to override the robot’s bad decisions, except in situations where the operator cannot exercise control.”⁶³ A current drawback to UAS operations is the interface that the pilots use to control the UAS. General Atomics, the MQ-9

awareness — “things that allow you to have some ability to understand when the aircraft is being painted by an adversary system.”⁶¹ The chart in Figure 8 shows the dramatic increase in medium altitude drone usage. Air Force spokeswoman Vicki Stein,

Reaper manufacturer plans to field a more “user-friendly” operational interface. Tucker, in his same article, continues, “Airmen will be more effective at interacting with the system if they are in-the-loop and active in making decisions about the autonomy and controlling its operation. Situations where the autonomy is activated without specific input from the airman should be minimized to situations of imminent danger (e.g., aircraft collision, defensive actions of a cyber-system) where the airman is either unable to respond, due to being incapacitated for example, or unable to make a decision in the extremely short timeframes available,”⁶⁴

Though current USAF policy and doctrine does not address autonomous UAS operations, Figure 9 does address many of the potential capabilities for these future assets. Some of the obvious abilities are to eliminate risk to US personnel, reduce personnel requirements, and

■ Persistence—ability to loiter over a target for long time periods for ISR and/or opportunity to strike enemy target

■ Undetected penetration / operation

■ Operation in dangerous environments

■ Can be operated remotely, so fewer personnel in combat zones—projects power without projecting vulnerability

■ Integrates “find, fix, finish” sensor and shooter capabilities on one platform

The slide features three images of UAS aircraft: a white aircraft with a V-shaped wing, a grey aircraft in a desert environment, and a dark green aircraft with a V-shaped wing flying over clouds.

Figure 9 Requirements for UAS Operations source: *Air Force Unmanned Aerial System (UAS) Flight Plan 2009-2047* rapidly integrate new technology and capabilities across the entire fleet. However, autonomy requires increased bandwidth and the security necessary to ensure that the UAS remains under

USAF control. Palmer in his research of autonomous UAS highlights a common fear: “To some, the idea of fully autonomous weapon systems making their own targeting and weapons employment decisions conjures up troubling images from movies like “Terminator” and “I, Robot.”⁶⁵

Deputy Chief of Staff, Intelligence, Surveillance and Reconnaissance (ISR), Lt Gen Dave Deptula’s briefing entitled, *Air Force Unmanned Aerial System (UAS) Flight Plan 2009-2047* predicts some of future UAS capabilities:

1. “Current UAS conduct intelligence, surveillance, and reconnaissance (ISR) missions, as well as some strike sorties.”⁶⁶
2. “The USAF believes its next generation of UAS will increase their capabilities to accomplish the following missions: electronic warfare, SEAD, ISR, CAS, Communication Relay, Collection, Dissemination, and Specialized ISR.”⁶⁷
3. “As technology improves, autonomous UAS missions will further increase to include things like Strategic Attack, Counter-air, and Air Interdiction.”⁶⁸
4. “Autonomous UAS platforms will take advantage of modular payloads to quickly add new capabilities and sensors.”⁶⁹
5. “Also, plans call for future autonomous UAS to be fully networked with manned platforms like the F-22 and F-35, allowing manned and unmanned platforms to be fully integrated.”⁷⁰

Palmer recognizes that the continual maturation of the UAS can permit “...the USAF to continue to operate inside extremely lethal Integrated Air Defense Systems (IADS), as well as areas that contaminated by chemical, biological, or radiological substances,”⁷¹ without risking a pilot’s life to do so.

One of the differences between the FW, RW and UAS platforms is where the pilot is actually located. In the case of a UAS, the pilot is on the other side of a video camera potentially in another part of the world, when they have “eyes-on” the target. Therefore, JTACs/FAC[A]s become even more critical when UAS are employed in the CAS role. JP 3-09.3 points out that “There is no requirement for the JTAC/FAC(A) to visually acquire the target or visually acquire

the attacking aircraft in Type 2 or 3 control, JTACs/FAC(A)s may be required to coordinate CAS attacks using targeting information from an observer.”⁷² An ideal observer for the JTAC/FAC[A]s is an ISR dedicated UAS having the capability of significant loiter time over the target area digitally integrated into the control loop.

Section VI: Description of Effectiveness Criteria

Time to Target

Limitations of RW aircraft, and the threats to them, are of key importance when planning employment of these assets. FM 1-112, Attack Helicopter Operations, identifies speed, as an important limiting planning factor accounted for; “Although Mission, Enemy, Troops Available, Terrain, and Time (METT-T) dependent, typical planning airspeeds are 100 to 120 knots during daylight and 80 to 100 knots at night. Speeds during marginal weather are reduced commensurate with prevailing conditions.”⁷³ Helicopters, while having speeds faster than a UAS, are slow when compared to a FW fighter or bomber. To mitigate the speed deficiency, helicopters usually deploy forward for increased CAS effectiveness.

Richard B. Andres and Jeffrey B. Hukill in their Joint Force Quarterly (JFQ), 4th quarter 2007 article, *ANACONDA: A Flawed Joint Planning Process*, reviewed flaws in the planning process that inhibited effective CAS early in the battle. Airpower deployment time was one of the five major errors that occurred in the planning process. Effective CAS does not just happen. Andres and Hukill said, “Failure to integrate air planners into the effort contributed to the mistaken belief that, even without preparation, the right mix of airpower would come together at the right place and time over the battlefield. Although the distances involved only mildly hampered long-range Air Force bombers, beginning the battle with land-based fighter aircraft

deployed near the battlefield would have considerably improved both close air support response time and forward air controller capability.”⁷⁴ Time to target becomes critical when distances traveled by land-based fighter aircraft approach those normally associated with long-range bombers. For UAS deployment, during ANACONDA, pre-positioning would have been a viable option to mitigate the slow airspeeds at which it operates.

Loiter Time over Target

Paul Moorcroft, in his book *The Rhodesian War: A Military History* covering Southern Rhodesia from the first resistance to colonial rule, noted that, “...helicopters and slow-moving fixed wing are considered significantly more effective at close air support in IW than fast-moving jets.”⁷⁵ A book translated by Lester Grau and Michael Gress titled, *The Russian General Staff, The Soviet-Afghan War: How a Superpower Fought and Lost*, describes CAS aircraft and

Additional Parameters

Parameter	B1-B	F-16 Block 50	A-10	AH-64D	MQ-9
Speed kt	470	470	380	143	270
Loiter Time (hr)	8	4	3	3	24
Transit Time (hr)	4	2	3	0	6
Mission Rate	0.794	0.793	0.85	0.682	0.766
Aircraft Turn Time (hr)	6	3	3	3	3

Figure 10 These speeds were drawn from Jane’s All the World’s Aircraft 2004–2005. A-10 speed reduced compensate for larger weapons load. The B-1B and the F-16 are both supersonic platforms, for which it’s assumed high subsonic. Developed from RAND Report MG301: Beyond CAS 2005.

tactics employed by the Soviets. It explains, “The Soviets in Afghanistan preferred the Mi-24 and the Su-25 over the Mig-21 due to better accuracy due to slower attack speeds and increased

loiter time.”⁷⁶ Figure 10 tabulates transit and loiter times of some of the U.S. CAS aircraft. For reference, the MI-24 has similar performance to the AH-64; the Su-25 while faster than the A-10, its weapons load is smaller; and the Mig-21 is similar to the F-16.

Weapon Loads (Certified Load-out)

Bombers such as the B1-B, B-2 and B-52 typically larger loads allowing them to engage significantly more targets per aircraft sortie than fighters, helicopters or UASs. The fighter’s initial design never included the capability to kill armor or hardened vehicles. The AGM-65 Maverick missile provides armor-killing capabilities but the F-16, for example, only carries two of these missiles. The A-10 employs the GAU-8/A 30mm cannon and up to six of the AGM-65 missiles. The MQ-9 Reaper and AH-64D employ the AGM-114 Hellfire to address armor and hardened targets. Figure 11 is a typical weapons load out on CAS aircraft.

Weapons Loads

Target	B1-B	F-16 Block 50	A-10	AH-64D	MQ-9
Stationary	24 tons (12 GBU-31s)	2 tons (2 GBU-10s)	3 tons (12 Mk-82s)	0.93 ton (8 AGM-114Ks, 76 Hyrda-70s; 30-mm cannon)	1 ton (2 GBU-16s)
Mobile	30 targets (30 CBU-103s or 30 CBU- 105s)	4 targets (4 CBU-103s or 4 CBU-105s or 4 GBU-12s)	10 targets (6 AGM-65s plus GAU-8 30-mm Gatling)	16 targets (16 AGM- 114Ks plus M230 30-mm chain gun)	10 targets (10 AGM- 114Ks)

Figure 11 Weapons Loads of CAS aircraft, tabulated from data obtained from *Courses of Action for Enhancing USAF “Irregular Warfare” Capabilities, A Functional Solutions Analysis*, PROJECT AIR FORCE, 2010 RAND Corporation

Accuracy/Effectiveness/Lethality

The UAS, or drone, has the unique capability to alter CAS strategy when employed during COIN and CT missions. Robert Pape in his book, *Bombing to Win: Air Power and Coercion in War* believes that, “Drones place no U.S. military personnel at risk. They do not require a large “footprint” of U.S. personnel overseas. They are armed with accurate missiles that have the capacity to target individuals, automobiles, and sections of structures such as rooms in a large house.”⁷⁷ The USAF utilizes a detailed planning process to assign specific weapons to specific UASs, assigned to specific targets.

JP 3-30, *Planning and Execution of Joint Air Operations*, details the Joint Air Tasking Cycle (JATC) responsibilities as a six-stage process. Accuracy/Effectiveness/Lethality falls under the Weaponing and Allocation stage of the overall JATC. USAF Intelligence Targeting Guide, *AIR FORCE PAMPHLET 14- 210 Intelligence* defines weapon effectiveness as “a statistical estimate of the results expected from specific munitions effects, target environment, damage criteria, delivery accuracy, munitions reliability, and ballistics.”⁷⁸ Within this process is “weaponing,” which is the actual planning and assigning the type and quantity of weapons required to achieve a desired effect, which could be to destroy a building or to kill an individual while minimalizing collateral damage as required by COIN and associated ROEs. Pamphlet 14-210 describes weaponing as “...the process of estimating the quantity of a specific type weapon required to achieve a specific level of damage to a given target, considering target vulnerability, weapon effects, munition delivery errors, damage criteria, probability of kill, weapon reliability, etc. It is the third phase in the conceptual targeting process, but it is embedded into target development, force selection, and execution planning.”⁷⁹ Criteria used during this planning process in determining weapon effectiveness and lethality includes,

applying the following indexes contained within the Joint Munitions Effectiveness Manual (JMEM). These criteria are “Mean Area of Effectiveness (MAE), Vulnerable Area (VA), Crater Diameter (DC), Effective Miss Distance (EMD), Bridge Effectiveness Index (BEI), Number of Hits (NH), Probability of Damage (Pd), and Probability of Damage Given a Hit (Pdh).”⁸⁰

Pape argues, “...air strikes directed at military targets and infrastructure—a strategy of denial—is more effective in coercing an opponent than is bombing civilian targets.”⁸¹ Denial is most effective when countering military only targets. Logistics tails, such as storage areas, material/resources, etc. are ideal candidates for air attack. Insurgents by their very nature have very little in the way of logistic needs, especially since blending in to the HN population is their strategy of choice to counter U.S. military power. Pape does not rule out the coercion of insurgents with air power, and says, “Effective coercion of insurgents requires separating them from the population that provides them with support. This is difficult to achieve with air power alone, since the groups targeted for attack typically lack the logistical infrastructure, clear control of territory, and massed personnel that make a strategy of denial effective.”⁸²

The insurgents have successfully used a continually adaptive strategy to counter U.S. COIN efforts. As ROEs attempt to limit collateral damage and civilian casualties, the insurgent has redoubled his effort to blend into the HN population thereby rendering much of the efforts of weaponeers ineffective or counterproductive. Walsh in his SSI report highlights the critical importance intelligence has in the weaponeering process. Walsh writes, “It is also very difficult to gain accurate intelligence on insurgent movements, especially when the United States does not have personnel on the ground in sufficient numbers to collect and place useful human intelligence in the appropriate context, which may lead to drone strikes that do little harm to their intended targets.”⁸³

Vulnerability to A2/AD Systems

Sydney J. Freedberg Jr., Deputy Editor Breaking Defense, reviewing the 2015 Center for Strategic and Budgetary Assessments (CSBA) report in an article entitled, *We Can't Always Count on Smart Bombs* describes some of the potential impacts of conducting CAS missions in other than permissive environments. Freedberg says “The rise of highly capable Integrated Air Defense Systems (IADS) such as the Russian S-300 and S-400 surface to air missile batteries, and the rising problem of Anti Access/Area Denial (known as A2/AD) present vulnerability issues for effective CAS.”⁸⁴

A Rand Corporation Report from 2005, *Beyond Close Air Support Forging a New Air-Ground Partnership* highlighted the same concerns about other than permissive environments as the CSBA ten years later. The report said, “In recent operations, U.S. aircraft have enjoyed near impunity flying at medium to high altitude, above the reach of ubiquitous low-level threats ranging from man-portable air-defense missiles to cannons. Flying against more-sophisticated radar-guided air-defense missiles, U.S. forces would have to employ stealthy aircraft and standoff weapons.”⁸⁵ Therefore, FW, RW and UAS become vulnerable when an adversary fields sophisticated IADS. Major Adam Pastor in his thesis, *Helicopters in Irregular Warfare: Capabilities, Challenges, and Missed Opportunities*, believes RW aircraft in particular may be more vulnerable “Due to their slower speeds and generally lower altitudes, helicopters are more susceptible to small arms fire and rockets propelled grenades (RPGs), and have limited reaction time to counter anti-aircraft missiles.”⁸⁶ Figure 12 gives a pictorial representation of a future challenge in an A2/AD environment. As air-defenses become increasingly capable of covering and overlapping larger areas, short range PGMs and their delivery systems, must evolve to

include stealthy aircraft and longer range weapons. A2/AD systems have the potential to render many of the current CAS assets operationally ineffective.

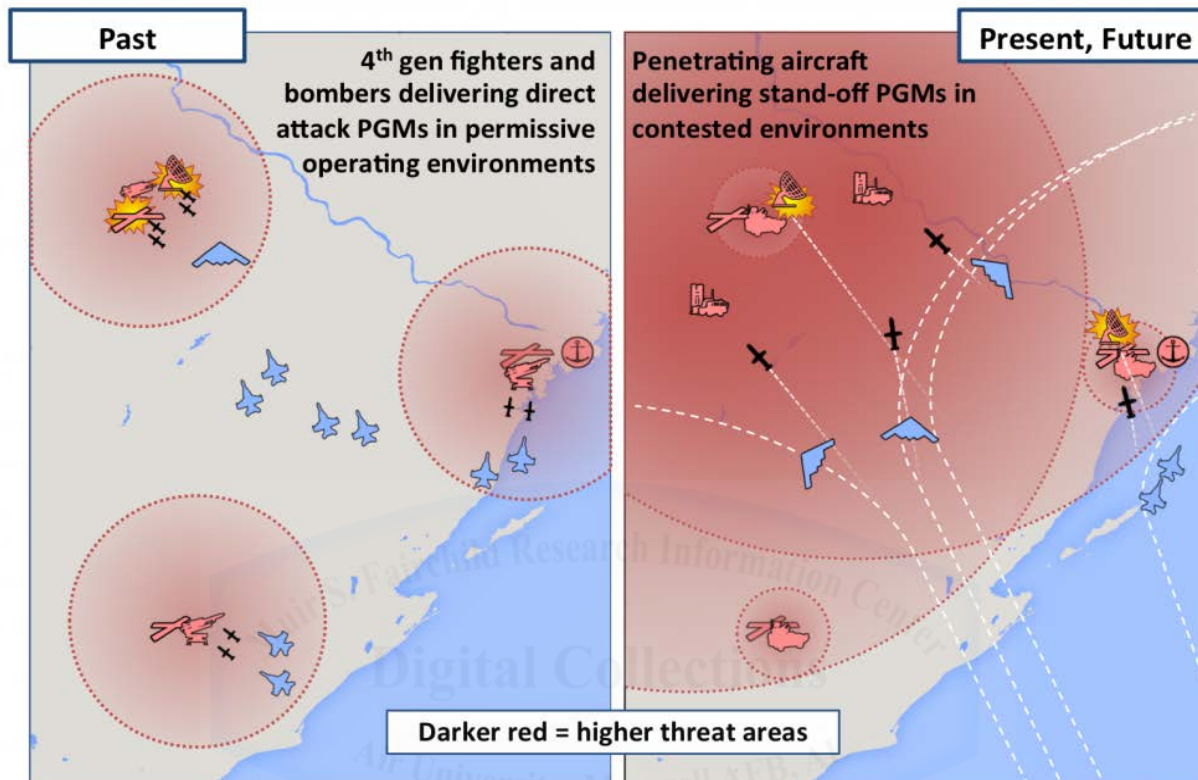


Figure 12 Permissive and Contested Environments for PGM delivery, reprinted from Breaking Defense, June 2015 <http://breakingdefense.com/2015/06/we-cant-always-count-on-smart-bombs-csba-study/>

A2/AD Threats

Countermeasures designed to scramble radar, jam GPS, disrupt laser designation and actually knock munitions out of the air are just some of the A2/AD threats COIN CAS aircraft may face. As these systems become more common, the single PGM for a single target may no longer be an accurate description. Freedberg addresses this concept in his review of the CSBA report “If the enemy can’t stop your weapons, you need to send just one to have 95 percent confidence of hitting any given target. However, if the enemy can stop a significant fraction of

your smart bombs, say 20 percent, you need to send two to achieve that same 95 percent confidence. If your weapons have only a 50-50 chance, you need to send five. Against a major adversary, like Iran or (in the nightmare scenario) China, we might run out of weapons well before we run out of targets.”⁸⁷ Figure 13 shows just how quickly the number of PGMs required can increase depending on sophistication of enemy air defenses.

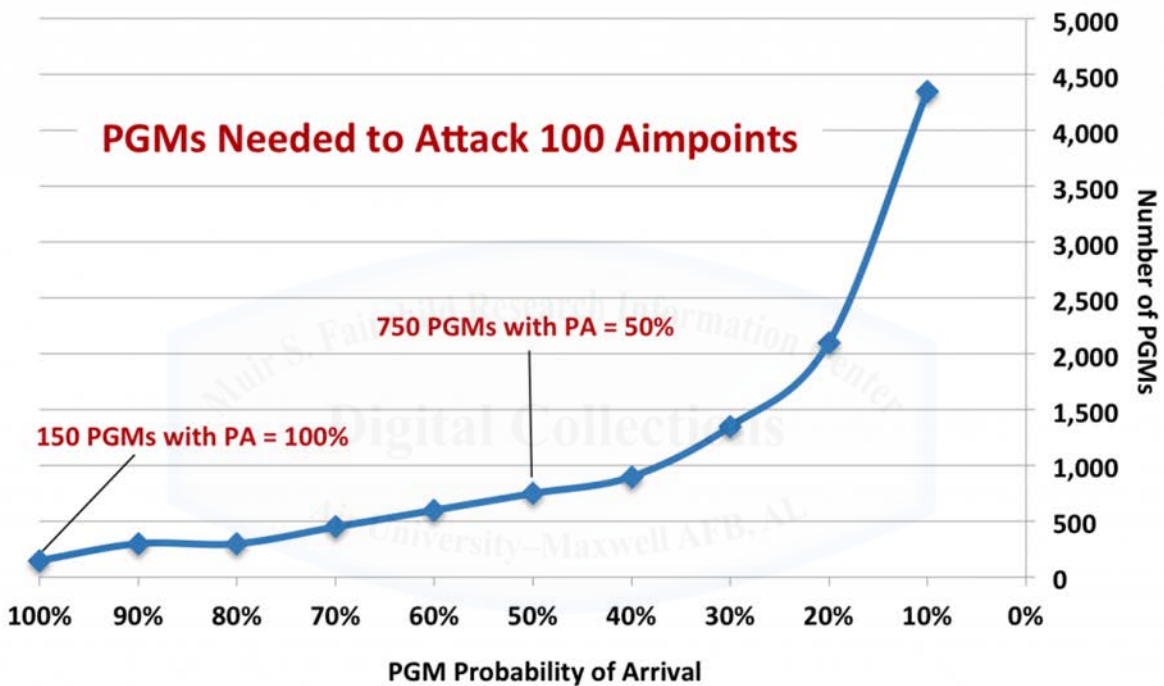


Figure 13 PGM Probability of Arrival, reprinted from Breaking Defense, June 2015
<http://breakingdefense.com/2015/06/we-cant-always-count-on-smart-bombs-csba-study/>

The commonly used weapons for CAS, previously shown in Figure 5, due to their relatively short employment ranges, would put all the aircraft in range of enemy air defenses even before they could launch a weapon in CAS. Currently, only the stealthy B-2, F-22 and F-35 would have a reasonable chance to penetrate the A2/AD zone, but then their released weapons

would become vulnerable to attack. Freedberg suggests, “New weapons could incorporate some degree of stealth and jamming, to make it harder for enemy defenses to detect and target them. Some might be hypersonic, achieving speeds above Mach 5 to dash through enemy defenses before they can react.”⁸⁸ The CSBA report addressed that possibility in the calculations of PGMs required to be effective in Figure 14. The calculations suggest that “smarter” weapons can improve the likelihood of weapon survival and effectiveness in A2/AD environments

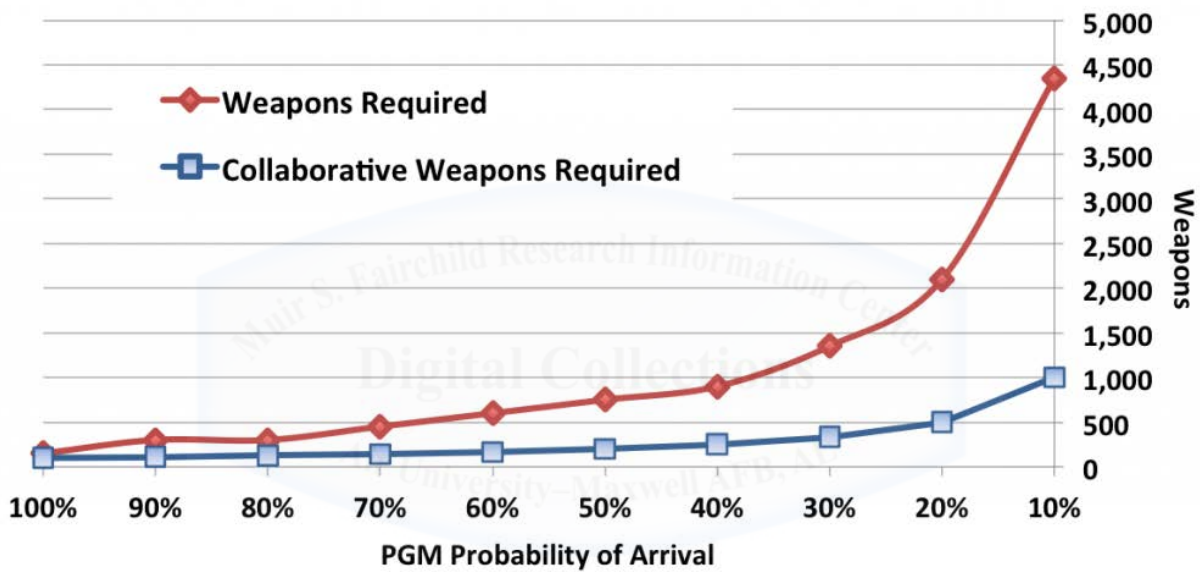


Figure 14 PGM Probability of Arrival with Smarter Weapons, reprinted from Breaking Defense, June 2015 <http://breakingdefense.com/2015/06/we-cant-always-count-on-smart-bombs-csba-study/>

GPS Jammers/Weather Vulnerability

GPS Jamming

GPS jammers at one time were only available to governments and major militaries. Since the proliferation of smartphones, and various other digital devices, consumer GPS jammers are available to prevent GPS monitoring cell phone, computer, or vehicle, or any device that utilizes a GPS signal. GPS jamming has been in the news. One news story is that in 2011, Iran supposedly captured an RQ-170 Sentinel drone, claiming it had jammed its GPS signal, thus redirecting the drone to land inside Iranian borders. GPS jamming would be particularly disastrous to people on the ground depending on CAS if PGMs within the last minute or two of terminal guidance suddenly lost targeting coordinates. A UAS with MITL control may be able to mitigate loss of GPS navigation, but the autonomous UAS such as the RQ-170 may be particularly vulnerable.

Weather

Highlighting the importance the Army puts on Weather, FM 34-81-1, Battlefield Weather Effects; introduction includes the following Army folklore: “ACT 3, SCENE 2. Location: Second floor of 3d Army Headquarters Building, European Theater of Operations, Germany. Date: December 1944. Players: General George Patton and Army Chaplain Colonel James H. O’Neill. Patton speaks . . . “Chaplain, write me a weather prayer.” This prayer was subsequently issued, along with a Christmas card, to all 3d Army troops on December 22, 1944. In part, it read: “Almighty and merciful Father . . . restrain these immoderate rains . . . grant us fair weather for battle . . .” And, of course, as history has so well recorded, “December 23 dawned bright and sunny.”⁸⁹

The following weather elements are some of the more obvious issues commanders must plan for when employing aircraft into the battlefield on CAS missions. Common weather effects include visibility, wind, clouds, temperature and humidity. These can impair the 'eyes on target' requirements for pilots or affect the precision of PGMs. Global Security report on FM 34-81: Weather Support for Army Operations, Appendix B defines these weather effects:

- **Visibility** - Infrared devices are degraded in range by any moisture source, precipitation, or moisture-absorbing smoke. Smoke and obscurant aerosols can be expected on medium-intensity to high-intensity battlefields and may be used locally to reduce visibility. In all operations, obscurants limit the use of aircraft and aerial optical and infrared surveillance devices.⁹⁰
- **Wind** - Strong winds limit airborne, air assault, and aviation operations.⁹¹
- **Clouds** - Extensive cloud cover reduces the effectiveness of air support. This effect becomes more pronounced as cloud cover increases, as cloud bases lower, and as conditions associated with clouds (such as icing, turbulence, and poor visibility aloft) increase. In a relatively unstable air mass, clouds are associated with strong vertical currents, turbulence, and restricted visibility aloft. Generally, Tactical Air Support (TACAIR) CAS missions and Military Airlift Command (MAC) aerial resupply missions require a ceiling of at least 1,000 feet.⁹²
- **Temperature and Humidity** - Temperatures of targets and objects on the battlefield at night are important for the use of thermal sights and FLIR devices. A difference in temperature or thermal contrast is required for these devices to "see" a target. Normally, heating and cooling are at a different rate for the target and background. Twice a day, in the morning and evening, targets without internal heating come to relatively the same temperature as the background. At this point thermal crossover occurs and the thermal device does not have the capability to "see" the target. ⁹³

The UAS with its extended loiter capability can mitigate the transient nature of weather by waiting for a clearing to complete its CAS mission.

Recommendations

Re-optimize CAS Roles

The January 2012 Defense Strategic Guidance (DSG), *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* says, "...the Joint Force will need to recalibrate its capabilities and make selective additional investments to succeed in the following missions:

- Counter Terrorism and Irregular Warfare.
- Deter and Defeat Aggression.
- Project Power Despite Anti-Access/Area Denial Challenges.
- Provide a Stabilizing Presence.
- Conduct Stability and Counterinsurgency Operations.
- Conduct Humanitarian, Disaster Relief, and Other Operations.”⁹⁴

CAS being an integral mission of the Joint Force, the 2012 DSG guidelines were used as a template to develop the recommendations presented in this research. The recommendations address the initial research question: can standard and non-standard aviation assets be combined to optimize CAS capabilities in a COIN, CT and IW environment, while utilizing current FW, RW, and UAS assets which exhibit the following traits - reactive, accurate, timely, capable of long duration and survivable.

CAS is a mission, not a specific aircraft label. That mission been executed effectively utilizing a variety of aircraft such as FW, RW, and UAS. The Air Force CAS Summit recognized that the UAS, while extremely effective, would not replace manned aircraft. However, increased utilization of the UAS will reduce the structural fatigue FW aircraft are being subjected too while requiring switching between CAS and CAP missions. To reduce FW aircraft flying hours, adopt Mesic's recommendation found in the 2010-RAND Report, *Courses of Action for Enhancing USAF "Irregular Warfare" Capabilities, A Functional Solutions*

Analysis by providing a UAS that's a "Transferable, Counterinsurgency-Dedicated Close Air Support and Armed Overwatch Platform. Such a dedicated counterinsurgency platform would help ensure persistent presence and engagement with Iraqi and Afghan partners while lowering operating costs and reducing the excessive flying-hour demands for high-performance aircraft such as the F-16."⁹⁵

Successful execution of COIN, CT and IW combat operations requires that PGMs employed from any CAS aircraft have their targets located and correctly identified to be effective. The capabilities listed in Lt General Deptula's briefing entitled, *Air Force Unmanned Aerial System (UAS) Flight Plan 2009-2047*, presented on page 28 of this document, are the basis for this recommendation. Expand UAS capabilities to include the continued pursuit of UAS autonomous data collection and correlation as described in HQ USAF *RPA Vector: Vision and Enabling Concepts 2013-2038*, "Identification of relevant cues in this vast amount of data requires vigilance well beyond human abilities. Autonomous correlation systems could search data collected and nominate potential targets. Employing unblinking autonomy to sift through the data will enable personnel to concentrate on translating processed data into information and making decisions based on that information. In these examples, autonomy does not replace humans but rather changes the way humans do tasks while exponentially increasing their effectiveness."⁹⁶ Autonomous UASs could provide 24/7 surveillance necessary to counter insurgent strategy of blending back into the HN population.

Improve the survivability of the UAS in A2/AD environments. Up until now, the U.S. has operated in permissive environments where the major threats to CAS aircraft were from MANPADS, Anti-Aircraft Artillery (AAA), RPGs and small arms fire. With the proliferation of advanced anti-aircraft missiles, the UAS must incorporate the recommendations in the USAF

RPA Vector: "...RPA must detect, avoid, or counter known threats, via traditional and innovative means, to enable operations in a range of threat environments, from permissive to A2/AD, while maintaining a persistent presence over the target area."⁹⁷ The report goes on to also suggest possible solutions such as, "...high subsonic/supersonic speed, low-observable/low-acoustic technologies, operating altitude, maneuverability, employment of air-launched SUAS (AL-SUAS), active/passive countermeasures, or expendable assets."⁹⁸

The recommendations made in this research attempted to associate the similarities in some of the hundreds if not thousands of previous recommendations from sources ranging from academically submitted research to reports from various a nonprofit research organizations. They all provided objective analysis and real solutions to enhance CAS effectiveness in COIN operations. The recommendations provided, specifically addressed the following traits are required for CAS to be effective - reactive, accurate, timely, capable of long duration and survivable.

Conclusions

Flexibility and Lethality Currently Exists

COIN and CT has involved into the preferred U.S. response to IW methods used by enemies who recognize that direct engagement with dominant U.S. conventional forces is a losing proposition. Lt. Col. Nimmo's research "*Bypass Ratio: The US Air Force and Light-Attack Aviation*" specifically addresses turbo-prop CAS assets and their employment for COIN. Expanding on that definition further to include UAS, the MQ-9 Reaper would also qualify as a turbo-prop CAS asset. Therefore, Nimmo's recommendation that the "investment in sustainable

Light-Attack assets can allow for long-term presence in areas, which are important to the US for stability and power balancing.”⁹⁹ With long-term presence as the critical factor, the increased reliance on the UAS can significantly reduce the CAS load currently on FW and RW assets. This flight hour reduction reduces the rate at which the structural life of the airframes of these assets degrades. These assets will then be available in greater numbers to meet the requirements of their primary missions.

UAS technology, as it exists today, is obviously not mature enough to eliminate a manned FW or RW attack aircraft in the CAS role. However, for today, and the near term, a mix of UAS’s and dedicated manned-CAS platforms, biased in favor of the UAS, presents a greater potential to increase the likelihood of success in COIN missions where CT and airstrikes against individuals are more frequent. These strikes most often utilize small to mid-size PGMs as the weapons of choice when the minimization of collateral damage takes precedent. In addition, the UAS today, or as envisioned in the future, will never directly replace the beloved and much maligned A-10 in the CAS role. Yet, the UAS’s design preserves some the unique characteristics of the A-10; the current crops of UASs are stubby, ‘ugly’ planes having straight wings, reasonably sufficient number of hard points, and a level of indirect fire support that can easily be on station 24/7.

Collaborative Integrated Training Required

As recently as 2005, a Rand Report commissioned as part of Project Air Force, titled: *“Beyond Close Air Support Forging a New Air-Ground Partnership”* recommend training and integration of CAS between the USAF and USA as a critical component of mission success. The report states: “Soldiers should routinely incorporate CAS in their tactical plans, not as a

substitute for artillery, but as a dynamically different source of fire. Airmen should recognize the unique demands of CAS and accord it a central place in their training. Separate training regimes tend to cause misunderstanding and, finally, a lack of trust. Only by training together at the tactical level can soldiers experience the enormous advantage of having friends in the air and can airmen grasp how best to help their friends on the ground.”¹⁰⁰

Regardless of the method of delivering CAS in the joint environment, collaboration, clear lines of communication, and training of JTAC/FAC[A]s is an identified requirement in JP 3-09.3, and at the tactical level is still a work in progress. In 2015 Lt. Col. Murray’s research “*Close Air Support: An Essential Element to Joint Combined Arms Operations*”, submitted to the Army Capabilities Integration Center suggests: “the current joint operational planning and air allocation planning models remain separated and do not adequately include tactical-level commanders. Battalion and brigade commanders have the greatest situational understanding, yet do not currently have the ability to plan for the employment of CAS.”¹⁰¹

The importance of integration, recommended in the Rand Report cited in Naylor’s August 2015 article, Inside *the Pentagon’s Manhunting Machine*. emphasizes expansion of the JP 3-09.3 training and integration requirement such that, “...within the area of close combat, attacks by fixed-wing and rotary-wing aircraft should be integrated with direct fire by automatic weapons, cannons, and missiles and with indirect fire by mortars, artillery, and rockets. Increasingly, air attacks should be integrated with reconnaissance and strike missions flown by UAVs.”¹⁰² Naylor, Murray, and Pimie et al, in *Beyond CAS*, all suggested integrated training leads to a combined and lethal projection of force of direct and indirect weapons as employed during CAS.

Appendix A

Abbreviations / Acronyms List

AAA	Anti-Aircraft Artillery
AL-SUAS	Air Launched Small Unmanned Aircraft System
ACLU	American Civil Liberties Union
BEI	Bridge Effectiveness Index
CAS	Close Air Support
CAP	Combat Air Patrol
COIN	Counterinsurgency
CT	Counter Terrorism
DC	Crater Diameter
DSG	Defense Strategic Guidance
EMD	Effective Miss Distance
F2T2EA	Fix, Track, Target, Engage, and Assess
FAC/A	Forward Air Controller-Airborne
FLIR	Forward Looking Infrared
FOIA	Freedom of Information Act
FW	Fixed Wing
GBU	Guided Bomb Unit
HN	Host Nation
IADS	Integrated Air Defense Systems
IED	Improvised Explosive Device
ISIS	Islamic State of Iraq and Syria
ISR	Intelligence, Surveillance and Reconnaissance
IW	Irregular Warfare
JATC	Joint Air targeting Cycle
JMEM	Joint Munitions Effectiveness Manual
JP	Joint Procedures
JSOU	Joint Special Operations University
JTAC	Joint Terminal Attack Controller
LOAC	Law of Armed Conflict
MAE	Mean Area of Effectiveness
MANPAD	Man Portable Air Defense System
MITL	Man in the Loop
NH	Number of Hits
OEF	Operation Enduring Freedom
Pd	Probability of Damage
Pdh	Probability of Damage Given a Hit
QDR	Quadrennial Defense Review

ROE	Rules of Engagement
RPA	Remotely Piloted Aircraft
RPG	Rocket Propelled Grenade
SEAD	Suppression of Enemy Air Defenses
SOF	Special Operations Forces
SSI	Strategic Studies Institute
SUAS	Small Unmanned Aircraft System
TACAIR	Tactical Air Support
TDM	Tactical Directive Memorandum
UAS	Unmanned Air-vehicle System
VA	Vulnerable Area



Appendix B

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