No. 28
December 2019

The Mitchell Forum

Remotely Piloted Aircraft Operations:
Lessons Learned and Implications for Future Warfare

By Lt Col John D. Duray, USAF

About the Forum

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Abstract

The use of remotely piloted aircraft (RPA) in the U.S. national defense architecture has grown exponentially since 2001, when they were utilized in the opening phase of Operation Enduring Freedom to dramatic effect. This paper aims to educate senior military commanders, allies, interagency personnel, and coalition partners about the progression of U.S. Air Force RPA operations since that time. The discussion will center around lessons learned from more recent operations, using vignettes and presenting five suggested points of policy consideration based on lessons from these scenarios.

More specifically, this paper will focus on the use and employment of the MQ-9 Reaper, the USAF's most ubiquitous RPA in the force today. The authors will accomplish this by using accounts of operations that, though scrubbed for security details, are reflective of the contemporary experience of the Air Force's RPA community. Key takeaways will be highlighted from these stories. Some of these lessons are rooted in airpower doctrine and have simply been ignored in contemporary RPA operations, while others are fundamentally unique to the employment of RPA in modern war. The lessons from these vignettes serve as a framework to explore the long-term implications for operations involving RPA. Through this, it is hoped this analysis will provide a framework to intelligently evolve and shape future RPA investment and employment.

Introduction: The Age of the RPA

Well into the night on October 7, 2001, less than a month after the September 11, 2001 terror attacks, an MQ-1 Predator fired an AGM-114 Hellfire missile as part of the opening stage of Operation Enduring Freedom over Afghanistan. The shot was the United States of America's first combat test of an idea years in the making, but only a few months into operational development at the time.[1] The Hellfire attempted to "flush out" the Taliban's supreme commander, Mullah Omar, from a meeting location, so as to set up a later engagement opportunity. This strike introduced the world to a new form of power projection: lethal weapons delivered from unmanned, remote piloted aircraft (RPA)—aircraft that also possessed unparalleled loiter and intelligence gathering capabilities.

Further advancement in RPA operational capabilities over the past 15 years has led to greater use of RPA providing intelligence, surveillance, reconnaissance and strike capability against individuals and small groups of hostile forces in various conflicts and contingencies around the world.

A modest start for this revolutionary capability in combat led to exponential growth for RPA in the years that followed, as requirements for combat aircraft in Afghanistan, Iraq, and elsewhere rose at a rapid clip.[2] The demand signal for RPA—measured in combat air patrols (continuous 24-hour coverage over a specific region)—swelled from four in 2004 to 65 in 2014, a more than 16-fold increase in operational demand in a single decade.[3,4] Further advancement in RPA operational capabilities over the past 15 years has led to greater use of RPA providing intelligence, surveillance, reconnaissance (ISR) and strike capability against individuals and small groups of hostile forces in various conflicts and contingencies around the world. While some analysts have noted these aircraft have been largely decisive in low-intensity conflicts where advanced weapons such as air defenses have not been employed, there is little dispute their unique capabilities continue to be called upon by combatant commanders around the world in a variety of operations.[5]

Despite these accomplishments, it is important to consider that perhaps the United States is failing to fully realize the transformational power of RPA. As the new U.S. national defense strategy pivots the Department of Defense (DOD) toward an era of great power competition, the question should be asked—what if a complete grasp of modern RPA capabilities could better facilitate American approaches to the fight against violent extremist organizations (VEOs), and drive the reset of U.S. military posture to better meet emerging near-peer competitor threats? A different approach to RPA employment and development is required if the United States is to fully realize the potential of these aircraft systems. Only by challenging some deeply held beliefs in airpower employment can the United States and its allies indeed tilt the battlespace in their favor, and address the pressing national security issues of today and tomorrow.

To help accomplish this, it is necessary to take a look at some examples of RPA use in modern combat since the September 11, 2001 terror attacks. What follows is a recounting of one of these missions, with some details obscured for operational sensitivity, but with the narrative and lessons largely intact for the reader.[6]

Vignette: The Camp Strike

Just a few years ago, multiple intelligence sources led the U.S. military to the discovery of a large terrorist encampment located in a desolate region far removed from urban centers of population.[7] The camp served as a jihadist training center. Nearly a hundred adult males were undergoing final preparations in their training program before dispersing to carry out attacks in the region and potentially around the world. Immediately, plans were formulated to eliminate these radicals by air strike before graduation.

Following the traditional mold for a large-scale air strike, the initial concept of operations (CONOP) called for bomber aircraft to traverse vast distances before releasing a large number of weapons on a target. Along with this approach comes the necessary support functions needed: scheduling and positioning refueling aircraft, obtaining overflight clearances for the bombers, and coordinating for personnel recovery, among other elements—time and resource intensive factors inapplicable to RPA that were, in the case of this camp strike, already providing persistent ISR overhead.[8]

Despite its unique capabilities for this particular target set, the MQ-9 Reaper option was settled on only as a tertiary plan once all manned aircraft were deemed unavailable. At last, when the other alternatives did not pan out, a four-ship of RPA was allocated for the strike.

When it became apparent that obtaining bombers for this mission was unlikely, given their high demand and limited fleet size, a subsequent attack plan was developed that centered around a four-ship formation of fighter aircraft. This plan necessitated an even more robust support structure, as the fighters needed to forward deploy closer in theater to put the target set within their combat radius. This required a massive undertaking involving the movement of support personnel and equipment in addition to the aircraft. These operational plans were developed despite the fact that multiple armed MQ-9 aircraft were already conducting daily surveillance and intelligence missions in the vicinity of the camp.

Two environmental factors introduced further complexity into planning for this particular mission. First, the camp was embedded deep inside a canyon with 60- to 80-foot vertical cliffs enclosing a valley floor only 15 feet wide. Any air launched weapons would need to be precisely aimed and "thread the needle," or accurately fly and impact between the canyon walls. Second, the jihadist leaders typically separated the students into two distinct groups, two to three miles apart (these became known as Group A and Group B). Any successful first-run attack required simultaneous effects delivered on each group. Any reattacks on surviving terrorists would need to be conducted expeditiously, as the surrounding terrain provided ample opportunities for immediate cover and protection.

Despite its unique capabilities for this particular target set, the MQ-9 Reaper option was settled on only as a tertiary plan once all manned aircraft were deemed unavailable. At last, when the other alternatives did not pan out, a four-ship of RPA was allocated for the strike. Three MQ-9 aircraft were flown by squadrons (henceforth labeled Reaper One, Reaper Two, and Reaper Three) in the same location while the fourth was flown by another squadron from a separate location (Reaper Four). The first three Reapers planned, briefed, and executed as a formation (or "flight" in Air Force parlance) bringing the geographically separated Reaper Four into the planning as much as possible before execution.

The strike package also carried a hefty punch for the mission. The four-ship of Reapers was equipped with a total of two 500-pound GBU-12 laser guided bombs (LGBs) and 16 air-to-ground Hellfire missiles. The resulting effects of this arsenal would be devastating. Once all approvals were secure, Reaper One teamed with Reaper Four to make a run on target Group A, dropping the pair of 500-pound LGBs on the group's location. Once established inbound, Reaper One passed an estimated "bombs-on-target" time to Reaper Two and Reaper Three, who targeted the Group B terrorists-in-training with four Hellfire missiles in order to achieve simultaneous effects.

The synchronicity turned out to be near perfect. Weapons impacts from the LGBs on Group A and the Hellfires on Group B were within a second of each other. This operational point bears emphasizing—a flight of four MQ-9s hit two separate target sets with six munitions on four different aim points with a time on target calculation formulated as the mission progressed, based on outside clearance authority. Reaper Two and Reaper Three teamed up to immediately conduct reattacks on the surviving jihadists. Prior planning, internal communication, and near real-time data sharing enabled an unprecedented display of efficiency (RPA pilots physically located together can speak into each other's headsets without delay on an intercom channel, for example). Reaper Three rifled off all four of its Hellfires on three separate reattacks in under seven minutes, all while adhering to stringent weapon parameters dictated by the extreme terrain. In one instance, Reaper Three shot one of its Hellfires on a group of terrorists without ever having even seen them, since Reaper Two had tracked the group and provided final weapons guidance for Reaper Three's missile. Reaper One and Reaper Four were left to conduct reattacks as solo aircraft, since they lacked the prerequisites for the seamless integration enjoyed by Reapers Two and Three—specifically, prior planning, an intercom channel, and real-time data sharing. As such, they were only able to employ three of their available eight Hellfires in the first 16 minutes following the initial strike.

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The final attack was conducted two hours later when, after extensive searching, Reaper Three found a group of eight enemy combatants hiding in a small ravine. Out of munitions, Reaper Three called over to Reaper Four (who still had Hellfires remaining), talked the crew on to the group of targeted combatants, and then coordinated a plan. The nature of the terrain only allowed a window of approximately 20 seconds that an MQ-9 could provide final guidance onto the target before becoming masked by the rocky terrain. Reaper Four shot a Hellfire into the ravine, target unseen, while Reaper Three came in from the opposite direction, crested the terrain and timed the aircraft's positioning so that final guidance was placed on the enemy in the last 10 seconds of the missile's flight.

By the conclusion of the mission, the camp was devastated. An estimated 85 percent of the its combatants were killed, with the other 15 percent wounded—a resounding success by all definitions.

Lessons Learned from the Camp Strike

With the above scenario in mind, it is important to examine some of the lessons learned for airpower application of RPA:

1. **The MQ-9 Reaper delivers unique capabilities in combat that distinguish it from traditional fighter and bomber aircraft—the aircraft traditionally used to target large groups of individuals.** The Reaper's slow airspeeds permit extended duration flight time required to see and target persons within steep or inaccessible terrain. In mountain passes, the speed of fighters and bombers permit only very short

execution windows before having their sensors and targeting capabilities masked. When combined with the ability to house much larger and more developed sensors (such as advanced cameras), an MQ-9 RPA is ideally equipped to find and track residual combatants that survive initial attacks. An aircraft flying at three times the airspeed of an MQ-9 with lower-fidelity sensors would have faced a monumental task in maintaining visual status on the jihadists in the camp strike described above.

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2. **Piloting an MQ-9 is not a mindless, button-pushing exercise as often depicted in film and video-game analogies.** Flying an MQ-9 Reaper requires a training-intensive skill set and a capacity for situational awareness very much like those required to fly manned aircraft. The correlation between playing a "first-person shooter" video game and flying an RPA is a myth perpetuated by limited exposure and ignorance of the realities of the task.[9] The simultaneous impacts on the initial run detailed in the first vignette were a result of quick mental math and aircraft manipulation to release weapons at a precise point in space and time that drove the final attack heading and impact angle—resulting in good effects at the same time on two different targets. Follow-on attacks also required expeditious, integrated employment to thread weapons through the narrow canyon openings. These types of attacks are the result of careful, robust training programs, U.S. Air Force Weapons School-caliber planning, and technological advancement since the early months of Operation Enduring Freedom. In short, a modern Reaper's capabilities in 2019 bear little resemblance to its MQ-1 Predator predecessor from 2001.

3. **Remotely piloted aircraft provide synergistic effects when employed together as a flight.** The benefit of RPA working together in groups is not a revolutionary discovery. History books are replete with examples of devastating effects that result when coordinated and massed airpower is brought to bear on an enemy. Fighters have operated in two and four-ship flights for decades. However, the idea of RPA operating in a flight is still a mostly foreign concept to the traditional fighter, bomber, and ground attack communities. Since 2001, operational planners have shown little qualm with simply tasking the closest RPA available just prior to the execution of a complex strike requiring extensive coordination among the participants.

The vital takeaway from this operation is that an RPA flight generates synergistic effects just like manned aircraft—through a mutual understanding of responsibilities and a shared mental awareness of the battlespace. This understanding and awareness is cultivated through extensive planning and briefing before a strike, along with real-time information sharing during execution. Bringing together single aircraft from separate squadrons just prior to execution is a practice that ignores the lessons of airpower history in the name of convenience. As seen in the previous scenario, Reaper Four was thrown into the flight just prior to execution. Although the performance was commendable given the circumstances, the aircraft was unable to conduct a coordinated strike with Reapers One, Two, and Three until two hours after the initial strikes. This first coordinated strike took 20 minutes to plan and execute. By comparison, the team of Reapers Two and Three conducted three separate reattacks in the first seven post-strike minutes. This example lays bare the fact that there is a great difference in capability in a given combat mission from a flight of RPA, vice the same number of individual aircraft.

4. **Decentralized execution is fundamental to successful RPA application.** Again, the lesson from the first vignette regarding execution is not revolutionary: decentralized execution of airpower has been a doctrinal principle of American combat operations since World War II.[10] However, RPA present an unprecedented opportunity for "reach-in"—a temptation too irresistible for many with tactical control (known as "TACON") over these aircraft. With unparalleled observation and communication capabilities during tactical engagements, commanders and leaders at all levels have violated this long-held tenet of airpower with a version of centralized execution, reminiscent of historically untenable Soviet models. Retired Air Force lieutenant general, Mitchell Institute dean, and noted airpower theorist David Deptula explains further:

   As a result of modern telecommunications and the rapid transmission of information to, from, and between various levels of command, we have many examples of "information age" operations in which commanders at operational and even strategic levels usurp tactical-level execution. This devolution of the construct of centralized control/decentralized execution to one of centralized control/centralized execution has reduced effectiveness in accomplishing mission objectives. We need discipline to ensure that "reach back" does not become "reach forward." Centralized control/centralized execution represents the failed Soviet command model that stifled initiative, induced delay, moved decision authority away from execution expertise, and bred excessive caution and risk aversion. The results of such a model against a more flexible command structure were evident in 1991, when Soviet-sponsored Iraq unsuccessfully applied similar [command and control] constructs against the U.S.-led coalition.[11]

   A previously agreed upon mutual understanding of roles and responsibilities during the terrorist camp strike depicted earlier gave all participating Reapers the ability to strike, track, sort, and re-engage surviving terrorists in a manner that was entirely internal to the flight, with final clearance given by the appropriate authority just prior to weapons release. Since 2001, this hands-off approach to tactical planning and execution is somewhat rare in RPA operations. However, it was an essential component to the success of this particular strike. The fluid and dynamic nature of kinetic engagements necessitates mission-command type orders that rely on the tactical expertise and situational awareness of those employing the aircraft, not someone watching a delayed feed from an operations center. [12]

5. **Focusing on platforms and not effects stifles RPA employment.** A fundamental shift in mindset is required

to fully actualize RPA potential in modern combat. By tying specific platforms to accomplish specific missions, vice desired effects, RPA will continue to remain underutilized. In the specific instance of the camp strike, the operation was unnecessarily delayed because planners sought a particular aircraft type with little to no discussion on what they wanted the aircraft to accomplish.

Along a similar vein, RPA aircrews today routinely participate in operational planning sessions where the ability to position fighter aircraft overhead to provide close air support (CAS) is deemed a "go/no-go" factor by both ground and air planners alike.[13] Yet, when queried to elaborate on the desired effects, ground force representatives routinely posture that, should they be engaged, they want airpower to assist in "breaking contact with the enemy" to help facilitate a return to safety. Although a flight of MQ-9s armed with a dozen Hellfire missiles and a few 500-pound bombs could achieve this effect, planners continue to be married to the platform-centric notion that only aircraft with an A-, F-, or B- in their designations can provide effective CAS.

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To be certain, many missions that call for CAS require the deep magazines of a bomber or the swift kinetic mass of an attack or fighter aircraft. These instances traditionally arise from operations where massive numbers of ground forces grab and hold large swaths of territory though. By viewing operational requirements through a traditional platform-centric mindset vice an effects-based one, risk continues to unnecessarily elevate and resources are unnecessarily utilized.

Vignette: The 15-Second Window

Several years ago, as part of global counterterrorism operations, U.S. and coalition forces were tracking a savvy senior leader of a prominent terrorist organization who proved exceptionally difficult to remove from the battlefield. His "pattern of life," or daily routines, presented limited opportunity for a successful engagement. After extensive study, a CONOP was developed to facilitate a strike on this jihadist within an incredibly tight window—while he was on a motorcycle returning to his home, after departing from a main road on his route but before entering a courtyard near his residence.

The planned strike presented two unique challenges.[14] First, the urban terrain and weaponeering solution dictated the shooting aircraft should position in such a way that it could not visually acquire the target's vehicle until it turned off the main road and entered the engagement window. A successful shot required the aircraft to release a missile within seven seconds of seeing the target in order to ensure impact before the individual entered the courtyard inhabited by civilians. Further adding a degree of complexity was the fact that, even at the slow speeds of an MQ-9, the strike opportunity allowing for successful employment would only exist for about 15 seconds.

The first problem facing this mission was a hard one to solve: how do you successfully position a shooting aircraft within a 15-second engagement window during the first seven seconds of the target departing the main road? A second challenge required additional problem-solving. On his return trip, the target came to a fork in the main road where he could continue one of two ways: Route A or Route B. Route A was simple—there were no further intersections along the route until the target left the main road and entered the engagement window. Route B was slightly more nuanced: there was an additional intersection along this route before the target left the main road. The shooting aircraft would need to maneuver to get into position before the target hit the additional intersection. Thus, if the target was held up at the additional intersection for even a few seconds, it could throw off timing and negate all previous planning.

The success of this strike on the senior terrorist leader was made possible by many of the same lessons and principles from the terrorist camp strike discussed earlier: a flight-focused approach to operations, paired with an intensive training program, and truly decentralized execution.

Three MQ-9s were allocated for the strike. Controlling authorities once again passed the tactical game plan responsibilities over to the MQ-9 flight with declared intent to strike the senior leader within the narrow window between the main road and the courtyard. Reaper One absorbed the flight lead role and began timing calculations to maneuver into position. Reaper Two was tasked with following the target's motorcycle as it traveled toward the engagement site. These two Reapers shared real-time tactical information that allowed them to continually update the calculated time the target would enter the seven-second window. This data sharing allowed Reaper One to position itself within the 15-second window at precisely the time the motorcycle turned off the main road and came into the field of view (FOV).

Reaper Three was tasked with staring at the additional intersection along Route B. Reaper One was able to view Reaper Three's feed of the intersection as well, and determine the possibility of the target getting held up at that intersection should he travel along Route B.

As the mission unfolded, the target chose to continue down Route B. However, constant updates on the target's distance and speed (from Reaper Two) and the intersection traffic (from Reaper Three) enabled Reaper One to successfully maneuver the aircraft into the 15-second window right as the target came into view off the main road. A Hellfire missile was immediately released and the target was eliminated shortly thereafter with no collateral damage effects.

Lessons Learned from the 15-Second Window

The success of this strike on the senior terrorist leader was made possible by many of the same lessons and principles from the terrorist camp strike discussed earlier: a flight-focused approach to operations, paired with an intensive training program, and truly decentralized execution. It also introduced three new areas on which to reflect.

1. **Data sharing brings asymmetrical advantages to bear in modern warfare.** The strike on the senior terrorist was heavily reliant on the latency-free sharing of information between aircrews. The ability of the aircrew operating Reaper One to harness and process the instantaneous information being shared by other aircraft enabled them to position their own aircraft within the weapon engagement zone (WEZ) at the precise time the target motorcycle entered the collateral-free strike zone. The razor-thin difference between success and failure in this scenario had nothing to do with the Reaper's technical specifications. It relied little on the MQ-9's ability to fly higher, further, or carry more weapons.

Instead, it relied on the RPA's ability to share information with the other aircraft around it. This information allowed the flight to get inside an adversary's decision loop and reorient quicker than the adversary could. This is a clear cut example of the late U.S. Air Force Col John Boyd's "OODA loop" in action (the "observe," "orient," "decide," and "act" cycle), successfully applied to RPA in modern combat.

Due to its rapid growth and expansion, however, the RPA career field has struggled to balance aircrew training and skills refinement with pressing operational needs. In particular, a decision making and training gap has steadily developed as the MQ-9 has grown more prominent in combat operations, due to how the Air Force specifically employs RPA.

2. **Risk acceptance enables rapid advancement.** The surgical precision of the senior terrorist strike is a testament to the advanced technology utilized on the MQ-9 in contemporary global operations against extremist groups. The tools needed to successfully execute within such narrow parameters were not available to aircrews even within the last decade. The rapid acceleration of software (and some hardware) enhancements have enabled RPA airmen to execute kinetic engagements that would not be proposed just five or six years ago. Although the specifics are beyond the scope of this paper, these capabilities were largely brought to bear through an RPA community and aerospace industry relationship that chose to accept imperfect solutions in the name of accelerated capability. Learning to work around minor "bugs" inherent to cutting-edge technology steadily became standard practice. This culture enabled the rapid fielding of the tools that enabled this particular terrorist strike.

3. **Tactical oversight offers enhanced RPA capabilities.** The ability of an MQ-9 squadron to place additional personnel in a ground control station (GCS) to support a traditional two-person crew transforms what that aircraft can bring to bear in combat. Judiciously applied, this "tactical oversight" boosts the tactical capability of the crew, elevating the success rate of complex engagements. This is a dynamic the Air Force can and should embrace in order to build more combat capability, and an experienced RPA community.

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In the instance of this strike scenario, tactical oversight within Reaper One enabled the pilot to focus purely on tactically maneuvering the aircraft into tight mission parameters while the oversight crew processed information passed from Reaper Two into a single time clock used by the pilot for positioning. Although the pilot was fully capable of converting distance and speed into time while maneuvering the aircraft, the ability to distribute the workload during engagements that leave little room for error is a force multiplier for RPA operations.

Vignette: The Attempted Rescue

On a calm, moonless night, a small group of U.S. special operations forces (SOF) parachuted from a transport aircraft in an attempt to rescue a hostage held in a village just a few miles away from the drop zone. Overhead in support of the operation were three MQ-9s and a U-28 manned ISR aircraft. These aircraft were tasked to provide support to the SOF team from insertion through the rescue operation and the exfiltration.

The MQ-9 elements overhead had direct radio contact with ground forces and, more importantly, instant access to intelligence as well, since it was passed over a network being monitored in the ground station of Reaper pilots.

The three MQ-9s were co-located, and operated out of the same RPA operations center (also known as a "ROC"). Inside the ROC, a miniature staff stood up to support the three flying crews. A mission director fielded phone calls and directed administrative functions, an operations director oversaw the three flying crews, and other support personnel were positioned to aid as necessary.

As the SOF team worked its way toward the hostage's reported location, it became apparent to the ROC director that key elements of real-time intelligence were taking too long to get to the ground forces via the joint operations center (JOC)—the main operations hub for the mission. The MQ-9 elements overhead had direct radio contact with ground forces and, more importantly, instant access to intelligence as well, since it was passed over a network being monitored in the ground station of Reaper pilots. After a quick discussion about transferring responsibility from JOC leadership to the MQ-9 pilots, the timeframe for this essential intelligence processing to ground forces went from a minute to under five seconds, a game-changing decrease in processing time. As the operation unfolded, a U-28 aircrew member was pre-positioned inside the ROC to provide subject matter expertise on U-28 capabilities as well as tactics, techniques, and procedures (TTPs) to the MQ-9 crews and ROC staff. This insight proved invaluable to the integration of MQ-9 and U-28 aircraft providing overhead support.

Unfortunately, as the team arrived at the location, it uncovered what is known in military parlance as a "dry hole"—the hostage had been moved from the village just prior to the raid. However, from the RPA aircrew perspective, the event offered an incredible real-world opportunity to explore several underutilized capabilities that RPA and the operations center could bring to bear on similar missions.

Lessons Learned from the Attempted Rescue

1. **The ability to port talent into any cockpit at any time is unprecedented in the history of airpower.** One of the most underappreciated aspects of RPA operations is that the aircraft "cockpit," in its traditional sense, has been

reinvented. Because of the physical setup of the ground stations that operate RPA, any individual can "enter" the air-plane while airborne. Although initially viewed as a serious threat to crew integrity, this unique feature opens the door to a host of operational possibilities. In the specific instance of the rescue mission described above, a U-28 expert was brought in to assist with airborne integration. In an operation involving CV-22 Osprey tiltrotor aircraft, a representative from the Osprey community could be brought in for consultation on landing zone (LZ) selection—either in preparation for an operation or in real time. Airborne integration could also be extended to fighters, bombers, and any number of other assets. This level of integration is not limited to aircraft alone. Just as easily, ground forces could send delegates to a ROC to educate and enable integration between RPA and supported ground elements. Although an appropriate level of oversight must still be exercised to preserve the integrity of the "cockpit," the ability to place subject matter experts in the aircraft at will is a tremendously underutilized component of RPA operations currently.

One of the most under-appreciated aspects of RPA operations is that the aircraft "cockpit," in its traditional sense, has been reinvented.

2. **RPA operations centers are uniquely positioned to fuse and disseminate information.** Modern ROCs rival traditional air operations centers (AOCs) in their ability to build situational awareness and monitor ongoing operations. Extensive networking infrastructure, large viewing monitors, and modular software-driven tools empower a robust information gathering hub. Although lacking the command and control capabilities of the Falconer AN/USQ-163 AOC, ROCs possess two exclusive features.[16] First, RPA operations centers allow operational directors to seamlessly communicate face to face with the aircrews that, operationally dependent, provide a majority of the data. It is the equivalent of a combined forces air component commander (CFACC), while in charge of an AOC, being able to jump into the cockpit of any F-15E, C-17, or KC-135 under his authority. Second, the land-based setup of the GCS enables an RPA cockpit to connect to modern combat untethered by bandwidth and connectivity limitations that plague most airborne manned aircraft. Today, GCSes are all encompassing and provide the physical and cyber infrastructure for networks to be connected, fused, and disseminated at will. In the attempted hostage rescue scenario depicted, only ground-based individuals had the ability to reliably pull real-time critical intelligence. And only aircrews possessed the ability to regularly talk to the ground forces. RPA crews, in this scenario especially, were uniquely positioned to do both.

A Way Forward for Air Force RPA

Although the lessons from these vignettes in and of themselves are important, where do they lead policy makers, DOD leaders, and Air Force officials? What considerations do these stories bring to attention? The following takeaways illustrate five implications that stem from further reflection:

1. **Airpower force posture in the fight against violent extremist organizations (VEOs) demands reconsideration.** Against violent extremists, the U.S. military has employed every aircraft in its arsenal: from the fifth-generation B-2 stealth bomber and F-22 fighter to more

numerous fourth-generation aircraft such as the F-16 and A-10. The airmen flying these aircraft have performed admirably, and have selflessly adapted their mission sets to meet operational requirements. However, in light of changing national priorities and finite resources, it is imperative to find ways to sustain the counter-VEO mission set over a longer period of time in a more cost-effective manner.[17]

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U.S. fighter and bomber aircraft are costly to sustain and employ, and should be done so appropriately. RPA like the MQ-9 offer efficiency benefits when it comes to cost per hour flying metrics.[18] For example, the cost per flying hour of a typical F-15E sortie is $24,171. In comparison, the MQ-9A rings in at $5,107 per flying hour and carries enough internal fuel to fly for over 24 hours.[19] The cost implications are self-evident.

Yet cost implications would be a moot point if the exquisite competencies of high-end aircraft were a requisite for success in the campaign against violent extremism. However, evidence suggests they are not. As the late Senate Armed Services Committee Chairman Sen. John McCain wrote in December 2017, using F/A-18s, F-22s, and F-35s to prosecute low-end counterterrorism missions "is overkill and only consumes the readiness of these platforms."[20]

The three vignettes from this paper highlight a small sample of the combat capabilities MQ-9 RPA bring to bear in contemporary operations. These capacities position this aircraft as an ideal capability to assume many of the mission sets being prosecuted by high-end fighters in today's counterterror missions. Redeploying the majority of American high-end fighter and bomber aircraft back to their home bases prolongs their service life and generates valuable aircrew training hours necessary to recapture depleted high-end skills. These are crucial steps to help prevent the demands of the fight against violent extremism from sapping Air Force readiness to address great power competition challenges from Russia and China.

As the *2018 National Defense Strategy* makes clear, the United States is transitioning back into "long-term, strategic competition."[21] America can no longer afford to keep killing flies with shotguns, and must move to appropriately and efficiently match defense requirements with resources. To do otherwise jeopardizes readiness in a way the U.S. can no longer afford. A thorough understanding of what the MQ-9 Reaper force brings to various mission sets is an essential step in correcting the airpower force posture against VEOs, and other low-end mission demands.

2. **Investment in information sharing will bring transformational advantages.** As a whole, the U.S. military must tear down parochial walls and allow information between disparate elements of hard power—tanks, ships, aircraft, infantry, and other forces—to flow more freely. The successful execution of the second vignette, the time-sensitive targeted strike on a terrorist leader, was made possible by the rapid exchange of information between platforms. Deptula, one of the key planners of Operation Desert Storm, believes that information

"will be the dominant factor in future wars." The military power that possesses the greatest data interconnectivity and situational awareness "will win in the conflicts of the future."[22]

Unfortunately, this type of interconnectivity is sporadic between air assets even within the same U.S. military service, and even worse between multi-domain assets from other services. An example of this problem is that even today the capabilities of Air Force aircraft currently operating in Afghanistan and the Middle East continue to be poorly integrated.[23] The problem of information sharing is not new, though. A chief complaint of the RQ-1 Predator's debut supporting Operation Allied Force in 1999 was its inability to relay data to manned aircraft.[24] Yet tactical solutions to these problems are increasingly complex, as years of proprietary systems and languages have taken over data link, video, and communication infrastructure.

Although a large portion of today's military modernization efforts appropriately focus on updating obsolete hardware, without an equivalent investment in connectivity between systems the U.S. military risks failing to gain the necessary leverage to succeed in the future. Air Force Chief of Staff Gen David Goldfein has recognized this trend and postulated that the effectiveness of any future combat system will be determined by how well it answers two key questions: "Does it connect? Good. Does it share? Even better."[25]

Although a large portion of today's military modernization efforts appropriately focus on updating obsolete hardware, without an equivalent investment in connectivity between systems the U.S. military risks failing to gain the necessary leverage to succeed in the future.

Continued investment in RPA infrastructure is necessary to accelerate the ability of these aircraft to connect and share data and information with other systems, other military services, and the rest of DOD's network. Current network and firewall limitations restrict the level of real-time data sharing to platforms flown from the same physical location (limitations depicted in the previously discussed vignettes). These artificial information silos must be broken down in order to facilitate effects that could be achieved when all assets share a common operational picture of a given battle and can instantly cue, track, and exploit sensor data shared between aircraft, sea vessels, space assets, and ground vehicles alike.

3. **Airmen must understand and begin articulating appropriate command and control (C2) relationships for RPA.** To fully realize the potential of currently operating and future RPA in combat, airmen must vehemently oppose any efforts to centralize execution and challenge command structures that fail to place airmen in positions where their "air-mindedness" could maximize the Air Force's contribution to joint operations.[26] In other words, airmen should influence airpower decisions at all levels of warfare.

RPA offer unprecedented opportunities for outside "reach-in" during tactical level execution—and senior commanders have indeed attempted to control all sorts of tactical elements, from aircraft positioning, to weapons placement, to camera field-of-view. However, this type of centralized execution stifles RPA aircrews from successfully exploiting fluid operational situations. A general officer would never consider reaching down to an Army platoon leader and instructing them how to shoot, move, and communicate during an actual firefight. Yet this type of intervention is considered standard practice in many MQ-9 engagements. Boyd once said that "there must be flexibility in command based upon a common outlook and freedom of action that encourages lower level combat leaders to exploit opportunities … within a broad loosely woven scheme laid down from central command."[27]

In operations void of ground or maritime forces (scenarios much like the first two vignettes), airmen should be influencing airpower decisions. The operational success of the first two vignettes was enabled by a flight of RPA—a collection of aircraft that planned, trained, rehearsed, and briefed together for days prior to executing the mission. However, the advocacy for conducting the operations as a flight, and not disparate aircraft from different units brought together just prior to the mission's start, fell to the lieutenants and captains flying surveillance sorties leading up to the strikes. At the joint task force planning level, the idea that MQ-9 RPA could bring synergistic effects as a pre-planned flight was mostly viewed as a foreign concept. Just as most airmen are inadequately trained and less experienced in planning ground schemes of maneuver for infantry or SOF teams, it is detrimental to joint force operations for untrained soldiers, sailors, and marines to dictate airpower employment.

RPA have profoundly transformed both the amount of firepower they bring to bear on the battlefield and the speed at which this ordnance can be delivered.

4. **MQ-9 capabilities and tactics have accelerated to a stage where operational planners need to fundamentally rethink aircraft allocation for close air support.** RPA have profoundly transformed both the amount of firepower they bring to bear on the battlefield and the speed at which this ordnance can be delivered. A flight of four MQ-9s can provide 16 Hellfire missiles and eight 500-lb bombs—all of which can be precisely guided to a target with laser indication provided from the same platform.[28] The Reaper's arsenal has also been expanded to include GBU-38 JDAMs, in addition to laser-guided munitions, which give mission commanders even more strike planning options.[29] Most important for combat effectiveness, an MQ-9 can deliver a Hellfire munition in an eighth of the time that a traditional fighter can deliver a bomb, and a quarter of the time it takes for a traditional fighter aircraft to conduct a strafing run using its gun.[30]

Despite this, the MQ-9 is still predominantly regarded across the Air Force as an ISR asset, and rarely incorporated into CAS scenarios. CAS planners, in many cases, simply do not consider the planned locations of armed ISR assets. According to the author of one *Air and Space Power Journal* article, a mission ISR plan "is completed on a different timeline by different people in a different division in the [Air and Space Operations Center] and published in a different document. If CAS and ISR integrate, they do so by luck."[31]

As previously noted, not all CAS scenarios are in fact appropriate for a flight of MQ-9s. However, military planners with a comprehensive understanding of MQ-9 capabilities who approach problem sets with an effects-based perspective and try to minimize platform-centric bias are in the best position to successfully allocate MQ-9s to conditions ideal for their exploitation.

5. **Remotely piloted aircraft and their associated operations centers present an ideal platform for entry-level multi-domain exploitation and rapid acquisition trials.** Compared with traditional aircraft, RPA cockpits (particularly those located in modern, fixed facilities) offer a prodigious amount of space and connectivity. Limited only by bandwidth and imagination, RPA offer unique opportunities to take advantage of multi-domain exploitation and use rapid acquisition capabilities to further the state-of-the-art.

Computer networks and satellite systems provide the backbone for today's RPA operations. As such, the triumvirate of cyber, space, and airpower are all synchronized under one roof. No other major weapon system relies on and incorporates all three domains so succinctly.

Computer networks and satellite systems provide the backbone for today's RPA operations. As such, the triumvirate of cyber, space, and airpower are all synchronized under one roof. No other major weapon system relies on and incorporates all three domains so succinctly. In pursuit of the Air Force's push to embrace multi-domain operations, RPA operations centers are ideally situated to begin exploring these types of missions, and could help create new multi-faceted problem sets for future American adversaries. [32]

Unsurpassed remote connectivity from hard wire, ground-based connections combined with a higher risk tolerance inherent to RPA squadrons makes these aircraft and systems ideal suitors to test and field new rapid acquisition technologies. Additionally, greater airborne loiter times and unparalleled mission effectiveness rates mean that RPA are aloft nearly all day, every day of the year in multiple areas of responsibility (AORs) around the globe. This unique dynamic grants program managers the flexibility to "move fast and break things," in acquisition parlance, without the fear of wasting the flying hours of traditional test aircraft such as fighters, bombers, and other assets.[33]

Conclusion: Leveraging Future RPA Combat Power

In current combat operations, the Air Force's MQ-9 is as different from its Operation Enduring Freedom-era 2001 MQ-1 forbearer as an F-16 is from a P-51. The capabilities of both RPA, and their aircrews, have grown enormously since late 2001. However, this transformation has collided with unintentional ignorance and military cultural differences rooted in traditional notions of force employment—both in the air and on the ground. This has led to sub-optimal utilization and investment considerations. The series of vignettes detailed in this paper reveal to all some important lessons, and highlight some potential paths forward for better RPA optimization.

Today, fighters and bombers are no longer the only option for mass strike. Modern RPA are more than just sniper rifles in the sky, and should be utilized as such. RPA can effectively conduct CAS, particularly with small ground team elements like SOF units. These two considerations alone should cause U.S. military leaders to fundamentally rethink American force posture for the fight against violent extremist organizations.

Remotely piloted aircraft operations are ripe for exploitation with centralized execution. Yet "mission-type tactics"—

where operational outcomes are emphasized more than any specific means of achieving them—are a central tenet of maximizing RPA potential. Despite exponential progress on some of these issues over the past decade, the U.S. military is still at the "Wright Brothers stage" of RPA application in combat. Continued investment in the RPA community is crucial to building on the momentum these assets are gathering in operations around the world. RPA are poised to serve in the future as multi-domain exploitation nodes, and ideal air vehicles for testing rapid acquisition programs and technologies. Lastly, information sharing through open system architectures is increasingly a fundamental tenet of modern warfare, and must remain a key component of defense acquisition reform to ensure future success.

The need to invest in the advancement and acquisition of RPA in the years ahead will only continue to increase. The United States' continued prosecution of low-intensity conflicts around the world, and the need to prepare for potential near-peer military confrontations, both benefit from an agile, decentralized, and well-connected RPA force whose lethality is intelligently incorporated into joint force operational planning. Military leaders with a commanding grasp of RPA capabilities, and a willingness to think beyond traditional aircraft mission sets, will be best positioned to take full advantage of every tool RPA can bring to bear in future conflicts.

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About the Author

Air Force Lt Col John D. Duray, a senior pilot with more than 3,200 flight hours in the MQ-9 and U-28, has extensive experience in combat and combat support missions. He has supported Operations Iraqi Freedom, Enduring Freedom, Inherent Resolve, and Freedom's Sentinel, and deployed to four different areas of responsibility.

Prior to his current assignment in the Pentagon's National Military Command Center, he served as aide-de-camp to Chairman of the Joint Chiefs of Staff Marine Corps Gen Joseph Dunford until the chairman's retirement in October 2019. He helped coordinate and integrate the chairman's activities, official functions, travel, and oversaw logistics support and finances for his office. Before his CJCS assignment, Duray was an Air Force Strategic Policy Fellow, where he completed rotations at the Mitchell Institute for Aerospace Studies and at the Federal Bureau of Investigation. He also served as a DARPA Service Chiefs Fellow. Duray previously served as an MQ-9 evaluator pilot and an assistant director of operations for the 3rd Special Operations Squadron, Cannon AFB, NM, where he directly supported global special operations missions. He also served as a U-28 instructor pilot, and a flight commander for the 319th Special Operations Squadron, Hurlbert Field, FL prior to transitioning to RPA operations. Duray graduated from Duke University in 2006 with a commission through the Reserve Officers' Training Corps.

The opinions and assessments expressed in this paper are the author's alone and do not necessarily reflect those of the Department of Defense or the U.S. Air Force.

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