The Swarm, the Cloud, and the Importance of Getting There First

What's at Stake in the Remote Aviation Culture Debate

Maj David J. Blair, USAF*
Capt Nick Helms, USAF

> *It has been written that it is difficult to become sentimental about . . . the new type of seaman—the man of the engine and boiler rooms. This idea is born of the belief that he deals with material things and takes no part in the glorious possibilities of war or in the victories that are won from storms. This theory is absolutely false . . . for there is music as well as the embodiment of power about the mechanisms that drive the great ships of today.*
>
> —Capt Frank Bennett, USN
> *The Steam Navy of the United States*, 1897

For all the ink spilled over remotely piloted aircraft (RPA) technology, knowledge of RPA culture remains in its infancy. Continuing the debate about culture, we argue first for the urgency of achieving manned-remote fusion in air warfare. Second, we maintain that the limiting factor in realizing that future is not technological

*The authors would like to thank Prof. Daniel Byman, Dr. Peter W. Singer, Prof. David Mindell, Prof. Christine Fair, Prof. Daniel Nexon, Lt Col Lawrence Spinetta, Maj Charles Kels, Capt Christopher "Filter" Baughman, and the reviewers for their advice and suggestions.

but cultural. That is, until the RPA community finds its voice and place in the larger service, this evolution of airpower remains unlikely. The task at hand does not call for reinventing airpower but rediscovering it. Many of our Air Force greats have much to say about building a culture of technical warriors. We simply need to apply the ideas of Gen Henry "Hap" Arnold and those like him to the enterprise of remote aviation.

The Swarm and the Cloud: A Hypothetical Vignette

Above a future battlefield, the long-range-strike bomber Saber 01 runs FENCE checks, preparing to penetrate layered defenses of the enemy's air defense system.[1] A thick "swarm" of unmanned combat aerial vehicles (UCAV) guards the leading edge of friendly airspace. When friendly aircraft pass through the swarm on the way to prosecute targets, a number of UCAVs join formation with the outbound strikers as escorts. Seamlessly, as Saber 01 transits through the front lines, seven small UCAVs join on its wing and swap data-link control from theater air battle managers to the bomber's combat systems operator.

Saber 01 serves as equal parts bomber and mothership, its stealth complementing advanced radar and data links, enabling the aircraft to command an automated squadron deep behind enemy lines. As the bomber crosses into enemy territory, the combat systems operator brings the local swarm in closer as the UCAVs begin to contend with the enemy's jammers. The tactical formation of these platforms, combined with a fully networked electronic warfare suite, enables Saber's crew to triangulate a precise fix on the target—an advanced theater surface-to-air-missile site. The enemy's air defense operators had long trained to defeat single antiradar missiles, but Saber 01's payload of hundreds of swarming micro air vehicles overwhelms their defenses with a networked mix of inexpensive warheads, sensors, and airframes.

Simultaneously, air battle managers behind friendly lines note that the surface-to-air-missile system has dropped off-line and direct the "cloud" of persistent air-to-ground RPAs to expand into the airspace it once occupied. A mix of high-end, long-endurance aircraft and large numbers of smaller aircraft fills the skies over permissive airspace. Using a variety of satellites, ground-based data links, and air-to-air network relays, this cloud provides a jam-resistant intranet covering both the air and ground battlespace, backed up by a seemingly endless reservoir of fires. High-end RPAs fly from ground or airborne links, which tap into the battlefield intranet rather than the individual aircraft itself. Doing so not only overcomes the jammer problem but also allows their crews to operate a number of aircraft at a time.

Meanwhile, a cyber warrior parries attacks from a desperate enemy who needs to disrupt the cloud's effectiveness but shows his hand with every attempt at cyber superiority. The enemy succeeds at corrupting data, but the cloud isolates the nature of the corruption and supplies visual feedback to gray-matter operators who decide to patch the tactical picture back together with old-fashioned radio communications. Meanwhile, our cyber warrior has successfully isolated the hack and goes on the counteroffensive with an attack ensuring that the enemy will have only a negligible chance of success on the same front for the rest of the campaign. The connectivity of the cloud and the capabilities of the swarm prove essential for the effective use of traditional platforms.

The smaller RPAs of the cloud revolutionize the role of Battlefield Airmen—instead of a radio, their primary armament becomes their data link to the cloud. Using a video-integrated helmet and a control system integrated into a glove, combat controllers can reach up and "grab" small RPAs with data links. Highly automated flight controls allow the controllers to task sensors and fires directly, right alongside the ground force commander. The combination of absolute information supremacy and inexhaustible fires proves devastating—air supremacy leads quickly to ground supremacy in this truly joint fight.

The enemy commander, however, is no fool. Knowing the American reliance on electronics, he plans to use electronic and space warfare to neutralize their technological advantages asymmetrically. Unfortunately for him, when jammers close down one link, information reroutes itself through unaffected parts of the network. Similarly, he hopes to use his tremendous numerical advantage on the ground, employing air defenses to hold American airpower at bay long enough to generate a fait accompli. This tactic proves no more effective as he soon learns that ground does not long remain red under blue skies. Air support has gone from retail to wholesale—the entire battlespace becomes a large-scale retelling of the battle of Al-Khafji, where torrents of persistent attack aircraft decimated entire ground-maneuver units in partnership with Marines and Rangers.[2] As his defenses melt away and front lines crumble, like the French commander at Agincourt, he laments the unfairness of it all. "Had it not been for those robots," he might say. But he would be wrong. Both sides had robots since missiles are as much robots as UCAVs. He simply used his less effectively.

Getting There First and Getting There Soon: The Centrality of Culture

The future described in this fictional account waits for whoever "gets there first." RPAs figure prominently in the spectrum of possible American security strategies. Offshore balancing, small-footprint engagement, air-land battle, and air-sea battle rely on aspects of airpower best provided by a synergistic mix of manned platforms and RPAs. We must, therefore, get RPAs right sooner rather than later.[3] America entrusts our Air Force to fly, fight, and win in air, space, and cyberspace—RPAs do all of the former, making use of all of the latter. They fit squarely within our service's raison d'être and rightly belong with Airmen.[4] Thus, as Airmen it is incumbent upon us not only to get there first but also to get there soon.

"Why the rush?" one might ask. "We all know that RPAs are the wave of the future, and we'll get there eventually." Making the case for urgency, one of the greatest minds of our time pointed out that when elite privilege is on the line, "later" is a dangerous snooze button that can all too easily become "never." Consider the following description by Maj Gene Bigham, a veteran fighter pilot, that appeared in an article published by *Air University Review*:

> [Aircraft] controlled by men located not in the cockpits but rather in the basement of the Pentagon, each of them controlling multiple drones through the use of a satellite link. . . .
>
> . . . As former Secretary of the Air Force John L. McLucas has written:
>
> I believe we are entering an era when RPVs [remotely piloted vehicles] will play an increasingly important role in helping airpower to serve the nation. . . .
>
> . . . Thus, the development of an Air Force position on drone roles and missions is not a future decision but one that must be made today.[5]

None of Major Bigham's arguments are particularly surprising; indeed, they dovetail nicely with much of the recent literature on the increasing role of RPAs. But the date of publication, November–December 1977, is quite surprising. Similarly, on no less than V-J day, General Arnold commanded us to "go to work on tomorrow's aviation," which "may be fought by airplanes with no men in them at all."[6] He made that statement in 1945, less than a year after an RPA successfully attacked antiaircraft staging areas near Bougainville Island during the Pacific campaign. Twenty-six years later, the first RPA-launched air-to-ground missile successfully destroyed a test target in the Mojave desert.[7] Yet, 64 years later, accounts of the RPA suggest it is in the Wright-Flyer stage of development.[8] Remote aircraft and their crews have been part of the story of aviation since its early days. This is not a question of adopting a new technology into the family but of recognizing the right of a long-standing branch of aviation to bear the family name.

How, then, do we get there? We assert that culture, not circuitry, represents the true issue of today—we have had the hardware for a while.[9] The Predator made its combat debut in 1995, two years before

initial operational capability for the B-2 Spirit and four years before the Spirit joined the Predator in combat over the former Yugoslavia.[10] Air Force MQ-1s and MQ-9s have logged almost 1.5 million flight hours. By accumulating more than 350,000 yearly, they will pass the F-15C's/E's current mark of 3 million hours within half a decade.[11] According to *Air Force Magazine*'s Aaron Church, "Within two to three years, Air Force officials predict, drone pilots will outnumber F-16 pilots."[12] Despite top cover from key senior leaders hailing from diverse aviation backgrounds, RPA culture still needs to find itself and its place within the larger Air Force culture.[13] The community needs leaders who will galvanize a creative RPA culture and embed those capabilities within the spectrum of air, space, and cyber power. Since remote aviation is no longer an emerging technology, its Airmen should not still be struggling to find cultural acceptance within their own service.

Major Bigham's article rightly predicted that the Air Force's challenge with RPAs would not be the hardware but how those who employ that hardware would find a home within the service. The hardware is here: the asymmetric needs of an asymmetric war brought about the RPA enterprise as we know it, and the new National Defense Authorization Act guarantees that it will not go away anytime soon. Despite the best efforts of Air Force leadership to normalize the enterprise, however, the place of the RPA community and the validity of its contribution remain a lightning rod within the larger service culture. We must work through this cultural tension together as a service if we wish to move forward, helping steer RPA culture between the extremes of an oppositional "chip on our shoulder" identity that will hamper synergies with manned aircraft and a demoralized "head held low" identity that fails to make full use of the platforms' capabilities. RPAs have moved well beyond the "dull, dangerous, and dirty" jobs of early drone lore, and we hold that Airmen's view of technical culture will move them even farther forward while avoiding this cultural Scylla and Charybdis.[14]

We assert that deep streams of airpower thought can answer the central questions of the evolution of RPA culture; moreover, we can largely attribute the broken elements of the RPA construct to neglect of the traditional Airman's view of technology. Toward that end, we examine three great Air Force leaders, each of whom explains different aspects of the interplay between culture and technology. General Arnold describes how the culture of a given technology must come into its own if it is to realize its full potential; Lt Gen Elwood Quesada argues that Airmen view technology as an amplifier of integrated human agency; and Col John Boyd observes how our definitions of cultural membership shift over time. By way of these greats, we anticipate a future that fuses manned and remote platforms—one in which Airmen exert vertical dominance of the battlespace with new levels of persistence and mass.

Technology = Humans + Hardware: General Arnold on Air-Mindedness

"It's an important capability, but it's not really what we do or who we are." This sentence seems equally apt describing the zeitgeist of RPAs in our service at present and that of aircraft in the Army of the 1920s. "What we do" and "who we are" find themselves inextricably tied to the development of a capability within larger strategic and cultural frameworks. General Arnold noted a world of difference between *aviator* and *aircraft operator* even though the two terms may encompass the same set of actions. Aircraft operators apply the tool of an aircraft to a set of tasks. For aviators, the aircraft becomes an extension of their will, enabling them to move through a new domain. Aircraft operators perform their tasks well and honorably, but aviators grasp the possibilities inherent in the technology and its domain. This air-mindedness allowed General Arnold to advance aviation from a tactical-support capability to a transcendent strategic community.

MIT professor David Mindell refers to technology as a physical component paired with a cultural component: "Technology, right down to armor plate and turret bearings, is part of culture. . . . Technical reality does not exist independent of cultural significance. Each influences the other, to the point where distinctions between them become difficult to maintain. . . . Both constitute what we call technology."[15] General Arnold's assertion was not simple service chauvinism or technophilic zealotry but an observation about the cultural embeddedness of technology.[16] On a bureaucratic level, a capability will flounder without advocates; on the deeper level of identity, dreams of strategic futures are most often rooted in one's own experience.

Dr. Dale Hayden describes air-mindedness as thinking of technology in terms of domains rather than tools.[17] Immersed in a domain, one begins to realize the possibilities contained therein. Common sense is common only to a specific context. Air-mindedness is a common sense of the air. During our first year in the Predator, we found learning the domain a much greater obstacle than learning the aircraft. In manned aircraft, space was important—satellite communications and the Global Positioning System (GPS) served as critical mission enablers. In the Predator, though, space became part of our domain. Orbits and footprints turned into practical rather than academic concerns as we realized that losing a satellite link could cut our control cables. Further, cyberspace folded into our world; servers acted as the eyes with which we scanned for other aircraft. Simultaneously, our ability to interpret engine sounds and vibrations through a throttle quadrant atrophied. Our experience of aviation became more abstract as we adapted to our new domain—neither better nor worse but different as we gained a new common sense. For instance, in RPA common sense, it is commonsensical to "demand" effects (rather than "command" actions) from a number of aircraft at once through a multiplexer when doing so increases intelligence collection without degrading kinetic capabilities.

RPAs are far more than long-endurance flying cameras, but to realize many of these possibilities, we need a brand of air-mindedness specific

to this technology. An infantry officer of the 1930s might consider an aircraft a tool of airborne artillery, but aviators saw the potential of destroying command centers deep behind front lines. An outsider might see a Predator as an 80-knot aircraft that takes two people to fly, but an aviator steeped in RPA culture would envision the possibilities of a flying focal point where the resources of the intelligence community intersect the needs of the tactical war fighter. Even though we have the hardware, we must think about the humans from which RPA culture will grow. Gen Wilbur Creech's passion for developing leaders seems sage counsel for the base that bears his name and the service that bears his imprint.[18]

Capabilities versus Cybernetics: General Quesada on Commanding Technology

As described by aviation bard Antoine de Saint-Exupéry, aviators do not stand outside their machine; rather, they step into another world in partnership with it.[19] Any conception of a pilot necessarily includes both human and machine. Therefore, the "human versus machine" meme in the current RPA discussion fails to capture the issues at stake. The true conversation does not deal with competition between humans and machines. Instead, it concerns the nature of cooperation between them. General Quesada offered the best response to this issue in 1959: "The day of the throttle jockey is past. He is becoming a true professional, a manager of complex weapons systems."[20] We have already moved into a world where "diffuse agency" replaces "direct agency"—where we use automation as an amplifier for our own capabilities.

The folktale of John Henry retells the myth of man versus machine through a "steel-driving man" who wins a grueling race against a steam-powered hammer at the cost of his own life. Not to diminish the poignancy of this classic American story, but Mr. Henry uses a hammer—a machine—to translate the force of his muscles into blows upon

railroad spikes. One might cynically reinterpret the fable as a dispute between the adherents of established and emerging machines. A deeper interpretation seems more appropriate, however: John Henry's iconic hammer is a machine that amplifies human agency, whereas the steam-powered hammer diminishes the role of humans in the world.

This distinction transposes well into remarkably similar quandaries faced by surgeons and pilots. Trained at a great investment of time and expense in manual dexterity and encyclopedic procedural recall, these elite groups find that advances in computers and robotics diminish the value of their painstakingly developed portfolios.[21] An apocalyptic battle between scalpel-wielders and computer engineers, however, would hurt the cause of medicine and serve neither group. Instead of digging in their heels, enterprising surgeons are finding ways to harness these advances, perhaps expanding their services globally to the disadvantaged through data links or employing robotics to access internal organs without major incisions.[22] By getting out in front, surgeons transform a threat to their profession into an asset that extends their capabilities. In the same way, the fear that pilots are replaceable is best answered by using the lens of technology to amplify the things truly irreplaceable about them. Technology then ceases to be a threat, allowing us to magnify our distinctively human capacities of judgment, reasoning, and situational awareness across the battlespace.

The first truth of special operations holds that humans are more important than hardware. In other words, technology exists to enable people to fulfill the mission. This is the *capabilities* view of technology: machines are amplifiers of human will, better enabling them to make something of their world.[23] By exercising dominion through technology, people gain greater command over their environment. The alternative is that humans are important to operate the hardware—that people are subsystems within larger sociomechanical constructs. This view, cybernetics, encloses people within closed control loops that regulate systemic variables within set parameters.[24] Rather than human

versus machine, the true discussion about the future of RPAs addresses capabilities versus cybernetics.

Many of the issues faced by RPA operators arise from unintentional cybernetic views of the crew. The demands of combat-driven explosive growth produced makeshift solutions, which became processes, procedures, and, ultimately, publications. As all too few crews struggled to meet geometrically increasing demands, the easiest answers sacrificed aircrew empowerment. The safest solution, given the circumstances, was closer supervision, but this choice had consequences.[25] Once entrenched within a community, a sense of dependency becomes very difficult to exorcise.

A more sustainable solution calls for embracing the traditional approach based on the aircrew's capabilities—assigning crews a mission and giving them all the resources to conduct it. From a capabilities view, crew members—in partnership with a fleet of maintainers and support personnel—take "their" aircraft into the fight to hunt down threats. Conversely, a cybernetics view uses a crew to supply a set of inputs that in turn produces x number of hours of intelligence, surveillance, and reconnaissance (ISR). Traditionally, Airmen have taken a capabilities-based view of technology, yet because of the addicting (and potentially illusory) sense of "thereness" that the platform provides to higher-echelon commanders, elements of the present RPA structure reflect a cybernetics approach. The tremendous connectivity of the platform is its greatest strength, but it can also become its greatest weakness if we do not take measures to ensure aircrew empowerment.

Restoring the "command" to RPA aircraft commanders would empower them to tap the resources of the entire intelligence community to better accomplish the mission and support their comrades. This entails (1) training RPA aircraft commanders on the wealth of relevant resources and bringing all onboard sensors under their control, (2) ensuring that ground-force commanders pass history, intent, and priorities to the crew rather than attempt to direct sensors manually, and (3) guaranteeing that air command and control respects the prerogatives of

RPA aircraft commanders as they would those of a manned aircraft. Ideally, this looks to a future in which aircraft commanders and ground-force commanders brief together, jointly building operational schemes of maneuver with authorities delegated from their respective chains of command.

To put forth one rule of thumb, horizontal connectivity between peer-level commanders is almost always beneficial. Vertical connectivity up and down the chain of command can become toxic in the absence of protections to preserve the initiative of tactical operators. In other words, never let your connectivity exceed your maturity. Lt Gen David Deptula's synergistic model of indivisible ISR offers an intercept trajectory for this goal by placing aviators in conversation with analysts in nested sensor-shooter loops.[26] Regardless of the implementation, the RPA must come into its own as a culture of Airmen by means of a capabilities-based view of technology that guarantees crew initiative, decentralized execution, and a say in the trajectory of the platform.

Pilot, Version 3.0: Colonel Boyd on "Destruction and Creation"

In his masterwork "Destruction and Creation," Col John Boyd synthesizes physics, cognition, and mathematics into the analytical engine that drives his observe, orient, decide, act (OODA) loop.[27] Whenever we act, we change the world; in doing so, we must reframe who we are in reference to this now-altered world. We constantly destroy old frameworks and create new ones to "improv[e] our capacity for independent action."[28] This is no less true for pilots. When pilots burst on the scene over the trenches of the First World War, they changed the ways of fighting wars, but they too changed as the technical horizons of aviation advanced.

We could express the core idea of a pilot as "one who fights from the air" or "one who fights in three dimensions."[29] An RPA pilot be-

longs squarely within this category, yet his or her inclusion within the prestige-laden term *pilot* was at first a point of cultural contention within the service. Encouragingly, Air Force Instruction 11-401, *Aviation Management*, the regulation that governs aeronautical ratings for the Air Force, chose the term "RPA Pilots" to describe officers who command an RPA.[30] The incorporation of RPA sensor operators into the prestigious category of career enlisted aviators is similarly provident. As always, advances in technology force us to consider how the core principles of identity intersect with the world of the possible and adapt our definitions accordingly. Tracing the evolution of the term *pilot* may help us grasp the issue at hand.

Colonel Boyd's OODA loop distills the nature of aerial combat. Whether a P-51 pilot pulling lead with machine guns or an F-15 optimizing a radar, the name of the game is getting inside the adversary's sensor-shooter loop before he does so. Because sensor and weapon technology determines the derivation of this solution, our examination of the evolution of the term *pilot* touches upon the eras of cannons, missiles, and networks. With each evolution, the definition of *flying* becomes more expansive and enables greater capabilities, the OODA loop becomes more abstract, and the pilot's "capacity for independent action" increases.

The Mark 1 pilot, a gunfighter, used his eyes as primary sensors, with some degree of off-board support from ground-based radar. This pilot's primary weapons relied on the Newton guidance system, a mix of cannons, machine guns, and unguided bombs whose flight path intersected their intended targets only through the pilot's aerial gunnery skill. The P-51 serves as an archetype of this era. With advances in sensors, beyond-visual-range combat grew in importance, and the critical skill set became arriving at a long-range sensor solution on a target while denying the same to an adversary. The archetypal F-15A Mark 2 pilot took control of a much wider swath of the battlespace, using electrons and an arsenal of semiautonomous unmanned aerial vehicles by the names of Sparrow and Sidewinder to wipe the skies clear. Maneu-

vering the aircraft into launch parameters for these rocket "drones" constitutes a far more efficient means of owning the OODA loop than spraying nine yards of machine gun rounds around the sky.

The war-winning pilot of the 1990s fights in three dimensions in a very different way than the war-winning pilot of the 1940s. The war-winning pilot of 2020 will fight in three dimensions in a way just as different as that of his or her predecessors—from lines of fire and arcing weapon-engagement zones to volumes of three-dimensional network space. For these pilots, the OODA loop is information supremacy: by first removing critical nodes and thus disrupting their adversary's connectivity, the pilots of 2020 can easily destroy the remainder of the enemy network in detail.

The F-22 is an astonishingly capable aircraft precisely because it embraces the idea of this Mark 3 pilot. Although F-22 pilots spend less time chasing needles on "steam gauges," advanced sensors and the power of two Cray supercomputers make them far deadlier than their predecessors.[31] Mark 3 pilots have the defining characteristic of placing their craft at the *schwerpunkt* (focal point) of the battlespace and there exert vertical dominance.[32] According to the chief of the Israeli air force's (IAF) long-term planning department, "The job of a pilot is vastly different from what it was. . . . The point is to see the enemy way before he sees you, and for that you need datafighters, not dogfighters."[33] It is intriguing, then, that the IAF adopted RPA technology early on. Abraham Karem, designer of what would become the Predator, formerly served as chief designer for the IAF.[34]

We hold that RPA pilots fit this Mark 3 definition well because they are cousins to the computer- and connectivity-enhanced C-17 and F-22 pilots.[35] A Predator's day-long endurance allows crew members to place their aircraft over critical nodes of an adversary's organizational structure, whether those nodes move or stay put. Efficient engines and a lightweight structure let the crew members outlast patient adversaries and strike targets at a time and place of their choosing. Sensor acuity and long dwell permit the aircraft to generate its own awareness of

the ground situation. The Global Information Grid connects the crew to a range of onboard and off-board resources, which they use to gain and maintain vertical dominance of the acre under their steady stare. Automated systems and data links are hardly unique to the Predator—those of the F-22 easily put it to shame. The factors that seem to estrange the RPA from the mainstream of "pilotness" are actually commonalities among our most recent redefinition of *pilot*.

Col Hernando Ortega, the Air Force ISR Agency's chief flight surgeon and a leading expert on RPA human factors, coined the term *telewarfare* (from Greek *telos* [far] and the familiar English word) to describe the experience of fighting from afar.[36] One of the most crucial implications of his term is that all air warfare in the era of long-range sensors includes some degree of telewarfare. Physical distance becomes less important than cognitive distance—entering coordinates into a GPS-guided bomb is a more abstract experience of combat than directing a laser-guided bomb on a high-resolution sensor. In one of the stranger turns of technology, early low-fidelity sensors made weapons employment more abstract, but advanced sensors make the act more cognitively immediate. A B-1 with an advanced targeting pod is likely more connected to the consequences of its weapons than is a B-17 bomber. This juxtaposition of increasing physical distance with decreasing cognitive distance in sensor-mediated combat reflects another commonality of Mark 3 piloting, manned and remote alike.

Folding RPA operators into the *pilot* category, along with F-22 operators and C-17 operators, does not dilute this evolving term but updates it to reflect the ways in which one fights in three dimensions with the technology of our day. True acceptance of this idea will require a reshuffling of privilege, and some individuals who find that the current state of affairs puts them at an advantage will likely resist such a reordering. The career of Gen Curtis LeMay demonstrates a higher road above these squabbles. Although he initially served as a fighter pilot, as one of a small cadre of navigation-qualified aircrew members, he instead filled the critically needed role of navigator in the run-up to the

Second World War.[37] In the same way, the needs of the service are exactly what drives the continued growth of the RPA community. Definitions should serve missions rather than the other way around. *Pilot* is a term of great prestige in the Air Force. In keeping with General LeMay's example, instead of allowing that word to capture us, let us instead capture it and use its gravity to slingshot our service forward.

Conclusion: Making Culture with All of Its Fixings

We began our discussion with the swarm and the cloud, a vision of an airpower strategy whereby Airmen gain and hold vertical dominance of the battlespace by fusing the best of manned and remote aviation. We argue that the primary challenge in achieving this future is not technological but cultural. Colonel Boyd closes the loop by describing how strategy and culture are bound together: "We must . . . *eliminate* those blemishes, flaws and contradictions that generate mistrust and discord . . . [and] that either alienate us from each other or set us against each other, thereby . . . paralyz[ing] us and mak[ing] it difficult to cope with an uncertain, ever-changing world. . . . We must *emphasize* those cultural traditions . . . that build up harmony and trust, thereby creat[ing] those implicit bonds that permit us . . . to shape as well as adapt to the course of events in the world."[38] To understand how one builds the cultural room for strategic evolution, we turn to history as an analogy for understanding the present.

In 1862 at the docks of the New York Navy Yard, the USS *Monitor* didn't look much like a ship at all, according to the definition of the day. Boasting no tall masts with sails blowing in the breeze, no broadside arrays of cannons, and no ornately decorated bowsprit, the squat ironclad stood no risk of being mistaken for Vice Adm Horatio Nelson's HMS *Victory*. The enlisted men who volunteered for service aboard "were made all manner of fun . . . for gooing [*sic*] to sea in a tank."[39] A year later, in the immediate aftermath of the pitched Battle of Hamp-

ton Roads, the Assistant Secretary of the Navy told the crew, "You don't look as though you were just through one of the greatest naval conflicts on record."[40] In the age of sail, battles resulted in "torn uniforms stained with blood, [and] hollow faces stunned by shellfire" while the crew of the *Monitor* emerged from victory covered only in soot and powder.[41]

Herman Melville weighed in on the passionless mechanical power of the ship: "Hail to victory without the gaud / Of glory. . . . / War's made / Less grand than Peace."[42] In considering the honor and glory of Appomattox Courthouse, he fails to mention the consuming, inhuman hunger and disease of the siege of Richmond that immediately preceded it.[43] Poets and screenwriters may favor Thermopylae, but with their friends' lives on the line, most warriors would prefer Plataea.[44] The crew of the USS *Minnesota*, saved from destruction at the hands of the Confederate ironclad CSS *Virginia* by the inelegant *Monitor*, surely preferred their survival to the sustenance of Melville's sentiments about the trappings of warfare. The greatest honor lies in what works—in what completes the mission and brings friends home alive without compromising the values for which we fight.

As described by Maj Charles Kels, the point of warfare is to win, and the way to win is to make sure that the other side bears as much of the risk as possible.[45] As a service, we would do well to remember that point. Admitting RPAs into the inner ring of our service culture is not a question of heroism but of simple effectiveness. An air force that perfects a fusion of manned and remotely piloted aircraft will dominate the skies (and the surface beneath those skies), but to build that force we must have people who understand both sides of that equation.

Toward that end, fostering RPA-minded aviators within the service will reveal airpower possibilities beyond those immediately apparent to traditional aviators. Ensuring some level of cross-fertilization between manned and RPA experience benefits both communities. As with any teamwork, these benefits must be built on a foundation of mutual respect. Putting this into practice, the Air Force has sent a

number of young captains who have completed their first flying tour in RPAs into follow-on tours in manned aircraft. Units receiving these pilots might learn much about how RPAs can assist their platforms if they choose to view RPA experience as legitimate. If we think structurally, replacing cybernetic processes with capability-based models empowers RPA pilots, which improves performance, effectiveness, and job satisfaction. As a service, coming to terms with the evolving nature of pilots inducts RPA aviators into the rich lore of flight and allows Airmen to tell the chapter of the Air Force story written over the last decade in the skies of Iraq and Afghanistan.

The most important aspect of martial culture, though, is pride—something we cannot transplant. It must be homegrown by the community out of a sense of shared values, accomplishments, mission, and purpose. The RPA community must take itself seriously—there is no room for being off altitude and hence becoming a hazard to other aircraft, and there is no excuse for watching a target for hours but failing to gain situational awareness of an upcoming operation on that target. The community must give no reason whatsoever to validate negative assumptions about it. This sort of seriousness comes from a passion for the mission. Thus, we return to the centrality of combat.

The rush of acceleration that accompanies an afterburning takeoff cannot motivate typical Predator or Reaper pilots—nor can the prospect of making assault landings on impossibly short dirt strips. Only one idea motivates them—that their actions help comrades in the line of fire and that their weapons help win the war and keep their countrymen safe. Combat occupies center stage for all Air Force aviators, but for RPA pilots it is the only thing on stage at all. A culture builds pride from what it does. RPA crews spend nearly the entirety of their flying time piloting aircraft in combat zones. Combat must be the deep soil from which the RPA community draws its pride. More than likely, no one will make a *Top Gun* movie about the glamour of long hours in a cargo container. There is, however, a long stream of headlines about al-Qaeda's thinning command structure. A saying from the days "when

Strategic Air Command was king" alluded to making movies and making history. RPA is making history.

Mindell describes the mechanism by which new technologies are accepted into the military mainstream—victory in battle.[46] This is hardly the scientific method since battles never take place in controlled conditions, and very rarely do we collect enough data points to attain statistical significance. But acceptance is as much a question of cultural narrative as of equipment optimization; thus, the retelling of a battle becomes as significant as the regression output from scientific testing. There is a certain logic to this—the crucible of uncontrolled conditions in the chaos of battle is a fitting final exam. Consequently, in the naval Battle of Hampton Roads during the Civil War, the duel of the *Monitor* and the *Merrimack* irrevocably inscribed the combination of steam power and metal-plate armor into the lore of the United States Navy. The gold standard of a military technology remains its ability to save lives. The *Monitor* saved the lives of the one remaining "wooden wall" at Hampton Roads from the Confederate ironclad that had already claimed two wooden frigates. This weighty discussion occurs in the currency of lives. The *Monitor*'s crew members were weighed and found worthy because they saved the people aboard the wooden USS *Minnesota*—despite the iron walls that gave them immunity.

The counter–improvised explosive device (IED) fight of Operation Iraqi Freedom represents the modern equivalent of the Battle of Hampton Roads. Although the RPA crews enmeshed in the struggle were not at risk, their actions radically reduced the threat to their friends on the ground by providing the ISR needed to dismember the IED network.[47] As the *Washington Post*'s Rick Atkinson describes in "Left of Boom," allied commanders realized that "if you don't go after the network, you're never going to stop these guys. Never."[48] The geometric growth of the RPA community was in the midst of this struggle to stem the killing tide. In partnership with intelligence professionals and special operations forces, the RPA's unblinking eye proves uniquely adept at disrupting social networks.[49] For all the talk of risk in the controversy over RPA

culture, the threats to ground forces drove the remote-split-operations construct that allows RPA crews to fly from outside the combat zone. The steady stare of the Predator protected our comrades on the ground, and that stare remained fixed on target through countless flight hours—hours that could be generated in much greater numbers from the United States than from downrange.[50] In Operations Iraqi Freedom and Enduring Freedom, risk to ground forces proved far more acute than to aviators; therefore, almost all the lives saved by the Predators and Reapers were those of ground troops. This realization should restore civility and camaraderie to the discussion about RPA culture—virtues heretofore sorely lacking.

Over the course of the past decade, RPA aviators have clearly experienced victory in battle, the standard for acceptance into military culture. Our enemy's own words testify to that fact. In war, the enemy always gets a vote. In this war, his vote was clear—Osama bin Laden himself confirmed the effectiveness of RPAs. Personal papers seized from his compound reveal a man left "distraught by drone strikes [and] al-Qaeda losses."[51] An astute airpower thinker described the link between victory and acceptance by joking that an RPA should sink the *Ostfriesland*, the vessel destroyed in a bombing demonstration by Gen Billy Mitchell in his quest to legitimate the role of aircraft in national security.[52] Off the top of our heads, we'd pick about a dozen high-value al-Qaeda targets over that battleship. ✪

Notes

1. FENCE checks are final combat checks conducted prior to entering hostile airspace.
2. Thomas A. Keaney and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf* (Annapolis, MD: Naval Institute Press, 1995), 94–95.
3. Specifically, we advocate a causal-constitutive view of the relationship between technology and culture. Technology shapes culture as culture shapes technology, and the evolution of this relationship depends upon initial conditions. Culture facilitates the effect of developing solutions, whether doctrine, training, or materiel. The most creative new-paradigm solutions are undoubtedly fostered by critically thinking, open-minded, interdisciplinary cultures. Thus, culture precedes capability. The other way around, where capability creates

culture, risks doubling down on an exploitable paradigm or creating an infinite loop of inertia. We do not imply that capability does not create culture—probably a historical fact. However, technology does not automatically create culture of value. Sometimes capability opens the minds of its users to foster a culture that iterates high-value solutions. In this case, the acceptance of RPAs as a group itself, responsible for generating the "right" culture, symbolizes the last 80 years of RPA/manned-aircraft synergy—or the lack thereof.

4. This is not to lessen the tremendous advances that the joint community has made on behalf of RPAs, but the nature of that relationship lies beyond the scope of this article. We argue for Air Force leadership—not exclusivity.

5. Gene Bigham, "The Future of Drones: A Force of Manned and Unmanned Systems," *Air University Review* 29, no. 1 (November–December 1977): 51–52, 64, http://www.airpower.au.af.mil/airchronicles/aureview/1977/nov-dec/bigham.html.

6. Lawrence Spinetta, "The Rise of Unmanned Aircraft," *Aviation History* 21, no. 3 (January 2011): 30.

7. Thomas P. Ehrhard, *Air Force UAV's: The Secret History* (Arlington,VA: Mitchell Institute Press, July 2010), 34–37, http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA525674.

8. Brookings Senior Fellow Peter W. Singer captures this zeitgeist well. See "Peter Singer: Drone Warfare," YouTube video, 22:49, March 2012, http://www.youtube.com/watch?v=gP3-TC3AMv8.

9. One of the most common misconceptions in the pop-culture discussion of "drones" is the "fetishization of technology." Incorrectly assigning agency to the technical construct, this error misses the nature of remote combat (as if the ubiquitous Tomahawk cruise missile were any less of a "robot killer"). Between 1990s-era computers and a network of 10 or more pilots, sensor operators, and analysts, the latter carries the weight of the causality. RPA technology is very much a human story.

10. Walter J. Boyne, "How the Predator Grew Teeth," *Air Force Magazine* 92, no. 7 (July 2009): 42–45, http://www.airforcemag.com/MagazineArchive/Documents/2009/July%202009/0709Predator.pdf; "B-2 Spirit History," Northrop Grumman, accessed 5 June 2012, http://www.as.northropgrumman.com/americas_bomber/history.htm; and "The B-2A Spirit: Kosovo and Beyond," Northrop Grumman Analysis Center, 16 February 2000, http://www.northropgrumman.com/AboutUs/AnalysisCenter/Documents/pdfs/B-2A-Spirit-Kosovo-and-Beyond.pdf.

11. Boeing and General Atomics Aeronautical Systems Inc., personal correspondence with the author, 29 May 2012.

12. Aaron Church, "RPA Ramp Up," *Air Force Magazine* 94, no. 6 (June 2011): 60, http://www.airforcemag.com/MagazineArchive/Documents/2011/June%202011/0611RPA.pdf.

13. Such senior leaders include the following former Air Force chiefs of staff: Gen Michael Ryan, Gen John Jumper, and Gen Norton Schwartz. See Boyne, "How the Predator Grew Teeth."

14. P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Press, 2009), 273.

15. David A. Mindell, *Iron Coffin: War, Technology, and Experience aboard the USS* Monitor, updated ed. (Baltimore: Johns Hopkins University Press, 2012), 15.

16. Maj Gen Charles J. Dunlap Jr., "Air-Minded Considerations for Joint Counterinsurgency Doctrine," *Air and Space Power Journal* 21, no. 4 (Winter 2007): 63, 64, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj07/win07/win07.pdf.

17. Dr. Dale L. Hayden, "Air-Mindedness," *Air and Space Power Journal* 22, no. 4 (Winter 2008): 44–45, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/win08/win08.pdf. For C-17 pilot Mark Jacobsen's well-argued critique of the contemporary use of *air-mindedness*, see "The Problem with Air-Mindedness," Building Peace, 19 February 2010, http://buildingpeace.net/2010/02/the-problem-with-air-mindedness.html.

18. Lt Col James C. Slife, *Creech Blue: Gen Bill Creech and the Reformation of the Tactical Air Forces, 1978–1984* (Maxwell AFB, AL: Air University Press in collaboration with the College of Aerospace Doctrine, Research and Education, 2004), http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA431075&Location=U2&doc=GetTRDoc.pdf.

19. Antoine de Saint-Exupery wrote that "the machine, which at first blush seems a means of isolating man from the great problems of nature, actually plunges them more deeply into them. As for the peasant, so for the pilot, dawn and twilight become events of consequence." Antoine de Saint-Exupéry, *Wind, Sand, and Stars: By Antoine de Saint Exupéry*, trans. Lewis Galantière (New York: Reynal & Hitchcock, 1940), 20.

20. Quoted in David A. Mindell, *Digital Apollo: Human and Machine in Spaceflight* (Cambridge, MA: MIT Press, 2008), 40.

21. For instance, see Herbert J. Rogove et al., "Barriers to Telemedicine: Survey of Current Users in Acute Care Units," *Telemedicine and e-Health* 18, no. 1 (January/February 2012): 48–53.

22. Pamela Whitten and Frances Mair, "Telesurgery versus Telemedicine in Surgery—an Overview," *Surgical Technology International* 12 (February 2004): 68–72.

23. Amartya Sen, *Commodities and Capabilities* (Oxford, UK: Oxford University Press, 1999).

24. David A. Mindell, *Between Human and Machine: Feedback, Control, and Computing before Cybernetics* (Baltimore: Johns Hopkins University Press, 2002). The field of cybernetics is far more expansive than described here. This article uses the term to describe a structural view of the relationship between people and mechanical constructs (in contrast to a view focused on individual agency). The Apollo program tended toward a capabilities view of technology, empowering the crew and enabling collaboration with ground-based mission directors. This proved essential in the safe recovery of the *Apollo 13* crew. The Soviet space program tended toward cybernetics, locking humans within heavily regulated parameters of behavior—witness the fact that ground crews padlocked Yuri Gagarin's spacecraft controls to prevent unauthorized manual piloting.

25. For example, see the amount of leadership and overhead for combat air patrol requirements in Col J. R. Gear, "USAF RPA Update: Looking to the Future," 3 June 2011, slides 38, 39, 43, http://www.theresearchcorridor.com/sites/default/files/Col-JR-Gear.pdf.

26. Lt Gen David A. Deptula, "Think Different," *Armed Forces Journal* 148, no. 4 (November 2010): 20–39, http://www.armedforcesjournal.com/2010/11/4939123.

27. John R. Boyd, "Destruction and Creation," 3 September 1976, http://www.goalsys.com/books/documents/DESTRUCTION_AND_CREATION.pdf.

28. Ibid., 2.

29. One might argue that the term describes one who fights "in the air," but doing so would exclude B-17s, P-47s, and any aircraft not intended to fight other aircraft (bombers and attack aircraft fight from the air to the ground).

30. Air Force Instruction 11-401, *Aviation Management*, 10 December 2010 (certified current 9 January 2013), 90, http://static.e-publishing.af.mil/production/1/af_a3_5/publication/afi11-401/afi11-401.pdf.

31. "F/A-22 Common Integrated Processor," Raytheon Corporation, accessed 5 June 2012, http://www.raytheon.com/capabilities/products/f22_cip/.

32. Clausewitz uses *schwerpunkt* to describe critical points of battlefield effort. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 485.

33. Amir Mizroch, "Nano Drones, Ethical Algorithms: Inside Israel's Secret Plan for Its Future Air Force," *WIRED*, 11 May 2012, http://www.wired.com/dangerroom/2012/05/israel-secret-air-force-plan/.

34. Peter Finn, "Rise of the Drone: From Calif. Garage to Multibillion-Dollar Defense Industry," *Washington Post*, 23 December 2011, http://www.washingtonpost.com/national/national-security/rise-of-the-drone-from-calif-garage-to-multibillion-dollar-defense-industry/2011/12/22/gIQACG8UEP_story.html.

35. The AC-130H/U and the AH-64D, with which the Predator/Reaper share a persistent air-to-ground sensor-shooter loop, are closer relations in another sense. A common sensor lineage ties these platforms together; they all maintain station-keeping profiles above their targets; and they have all have been fitted with Hellfire missiles (though only experimentally on the AC-130). However, the automation and computer-mediated control that figures strongly in the estrangement of the RPA do not play as strong a role in these platforms as they do in fifth-generation fighters. This commonality is one of mission rather than of the conception of "pilotness." In fact, one of the reasons we reject the term *drone* is that it conflates autonomy with physical presence—by the standards of processor speed and algorithms, an F-22 is a much better "drone" than the MQ-1.

36. Col Hernando Ortega, personal correspondence with the author, February–June 2012.

37. Walter J. Boyne, "LeMay," *Air Force Magazine* 81, no. 3 (March 1998): 63, http://www.airforcemag.com/MagazineArchive/Documents/1998/March%201998/0398lemay.pdf.

38. Frans P. B. Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd* (London: Routledge, 2007), 216–17.

39. Mindell, *Iron Coffin*, 48.

40. Ibid., 1.

41. Ibid., 2.

42. "A Utilitarian View of the Monitor's Fight," in Herman Melville, *Battle-pieces and Aspects of the War* (Cambridge, MA: Da Capo Press, 1995), 61–62.

43. Jay Winik, *April 1865: The Month That Saved America* (New York: HarperCollins, 2001).

44. The Battle of Thermopylae (480 BC) pitted a force of several thousand Greeks against more than 100,000 Persians. During this archetypal last stand, the Greeks held for days against the Persian forces but ultimately succumbed to their overwhelming numbers. The Battle of Plataea (479 BC) saw the defending Greeks face a more manageable three-to-one numerical disadvantage against the Persian invasion force; surmounting this disparity, the

Greeks emerged victorious. Herodotus, *The Histories*, further rev. ed., trans. Aubery de Selincourt (London: Penguin Books, 2003).

45. Maj Charles G. Kels, "Don't Deride Our Drone and Cyber Operators," *Hill's Congress Blog*, 26 April 2013, http://thehill.com/blogs/congress-blog/homeland-security/296407-dont-deride-our-drone-and-cyber-operators.

46. Mindell, *Iron Coffin*, 9, 18, 45.

47. That is, risks comparable to "outside-the-wire" ground forces subject to IED attacks and direct enemy fire. Deployed RPA launch-and-recovery crews experience the same risk of residual indirect fire as other "inside-the-wire" personnel (the latter risk geometrically smaller than the former). The highest risks at present for manned aircraft are likely the accumulation of small amounts of daily risks associated with normal aviation mechanics along with regional and global potshot terror attacks, both of which bear heavily on questions of valor and heroism vis-à-vis RPA pilots as RPA crews share the terror-attack risk but not the aviation-mechanics risk. The relationship between risk and lethal force is not easily captured by the increasingly irrelevant geographic heuristic of a "combat zone." One challenge of the present discussion is that heroism, driven by sacrifice and risk, is increasingly decoupled from combat—a function of direct, lethal responsibility. Therefore, a manned crew flying outside the combat zone that chooses to face these small risks day after day for years is heroic—but not in combat. An RPA crew employing lethal fires is in combat; although capable of extraordinary achievement, it is not heroic. An attack-helicopter crew in the combat zone is heroic and in combat—and ground forces even moreso. Fully exploring the evolving relationship among risk, lethal force, combat, and heroism lies beyond the scope of this article. However, for a more complete discussion of risk-due-to-enemy-fire comparisons between RPA crews and manned aircraft, see the letters to the editor from Maj Christian A. Senn and Maj Dave Blair in the July–August 2012 issue of *Air and Space Power Journal*, 149–60, http://www.airpower.au.af.mil/digital/pdf/articles/Jul-Aug-2012/RR-Senn.pdf.

48. Rick Atkinson, "'If You Don't Go after the Network, You're Never Going to Stop These Guys. Never,' " *Washington Post*, 3 October 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/10/02/AR2007100202366.html.

49. Michael T. Flynn, Rich Juergens, and Thomas L. Cantrell, "Employing ISR SOF Best Practices," *Joint Force Quarterly* 50 (3rd Quarter 2008): 56–61, http://www.ndu.edu/press/lib/pdf/jfq-50/JFQ-50.pdf.

50. David A. Deptula, "Unmanned Aircraft Systems: Taking Strategy to Task," *Joint Force Quarterly* 49 (2nd Quarter 2008): 50, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA516795.

51. Jordy Yager, "Brennan: Bin Laden Left Distraught by Drone Strikes, al Qaeda Losses," *Hill*, 30 April 2012, http://thehill.com/blogs/defcon-hill/policy-and-strategy/224569-brennan-bin-laden-feared-drones-sought-to-rebrand-al-qaeda.

52. Interestingly, only 23 years later, RPAs punched holes in the hull of the *Yamazuki Maru* on 30 July 1944 with drones while manned aircraft remained no closer than seven miles to the target ship. James J. Hall, *American Kamikaze* (Titusville, FL: J. Bryant, 1984), 163–68.

Maj David J. Blair, USAF

Major Blair (USAFA; MPP, Harvard Kennedy School) is a PhD candidate at Georgetown University. He is an MQ-1B instructor pilot and an AC-130 pilot. Prior to beginning his doctoral research, he served as assistant operations officer (war fighting) for the 3rd Special Operations Squadron. Major Blair has authored works on the culture of remotely piloted aircraft, counterterrorism, deterrence, cybersecurity, and transnational criminal organizations for *Air and Space Power Journal*, *Small Wars Journal*, and the Department of Defense's Strategic Multilayer Assessment Office.

Capt Nick Helms, USAF

Captain Helms (USAFA; MS, USAF Test Pilot School) is the chief test pilot and assistant director of operations for Detachment 3, Air Force Life Cycle Management Center, Gray Butte Field, California. He is responsible for test and evaluation of medium-altitude remotely piloted aircraft (RPA) capabilities. He previously piloted F-16 aircraft with the 34th Fighter Squadron and served as a flight commander for the 42nd Attack Squadron, piloting the MQ-9 RPA. Captain Helms is a distinguished graduate of Squadron Officer School and the USAF Test Pilot School.

Let us know what you think! Leave a comment!

Distribution A: Approved for public release; distribution unlimited.