Nightfall and the Cloud

Examining the Future of Unmanned Combat Aerial Vehicles and Remotely Piloted Aircraft

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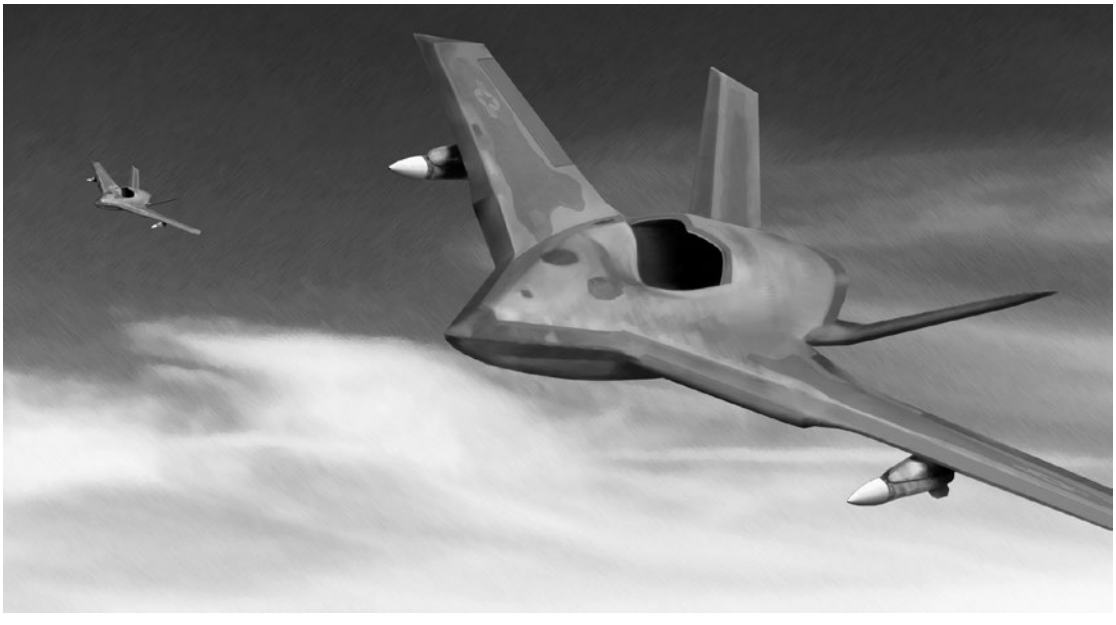
It is very easy for ignorant people to think that success in war may be gained by the use of some wonderful invention rather than by hard fighting and superior leadership.

—Gen George S. Patton Jr.



In early 2008, the United States began a dramatic increase in the use of remotely piloted aircraft (RPA) as part of the global war on terrorism. Since that time, there has been no shortage of scholarly articles on and public discussion of the legal implications of RPAs, the hazards of their employment in military campaigns, or the prospects for the diffusion of RPA technology. The debate over these aircraft

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and future unmanned combat aerial vehicles (UCAV) is generally one of extremes, much as the one about the value of air warfare more generally for the past century. As early airpower advocates extolled the potential of the air weapon to bring about a decisive end to conflict through the threat of aerial bombardment, critics decried the human suffering that would inevitably result and sought to ban the practice outright.[1] Experiences of the twentieth century would demonstrate how airpower advocates overestimated the likelihood of success of strategic bombing given the technologies available at the time, with doctrines and technology catching up to the theory in the 1990s at the earliest.[2]

The RPA debate has undergone a similar transition from hype, to recognition of shortcomings, to relative acceptance of existing capabilities while looking ahead to the next transformative technology that will almost inevitably be a game changer. The early years of the United States' RPA campaign saw publications touting the potential of these vehicles and other robotics to revolutionize warfare.[3] More current critiques appear to have accepted RPAs in their present form but warn against what they see as the next step of autonomous attack. The prospect of US intervention in Syria in 2012 highlighted the shortcomings of the latest generation of RPAs in a contested air environment.[4] Furthermore, the ongoing debate among the United States and allies at both the diplomatic and domestic politics levels has likely constrained the expansion of RPA programs against al-Qaeda affiliates. One critic of "robotic warfare" put this larger trend most succinctly: "This debate goes well beyond drones, as they are yesterday's news."[5]

Although thoughtful discourse on the realistic future applications of RPAs from an operational or tactical perspective has been in short supply, over the past few years, articles in *Air and Space Power Journal* have elevated this aspect of the debate with several treatments of the subject, notably Maj Dave Blair and Capt Nick Helms's "The Swarm, the Cloud, and the Importance of Getting There First" and Capt Michael Byrnes's "Nightfall: Machine Autonomy in Air-to-Air Combat." Each of their perspectives adds numerous insights into the future capabilities of RPAs and, eventually, toward more autonomous UCAVs.[6] Although Byrnes, to an extent, argues that his vision contrasts that of Blair and Helms regarding the role and degree of automation in future Air Force missions, both share a common vision of autonomous aircraft increasingly taking on the air-to-air role in future conflicts against near-peer competitors. The sharpest contrast between the two perspectives is the level of interaction between human pilots and future UCAVs, Byrnes arguing that the technological attainability of automation in the future, together with reaction and performance considerations, will inevitably lead to a takeover of air-to-air combat.

This article argues that the transformation of airpower to a UCAV-centric force is a more difficult proposition than simply a technical hurdle to overcome. Substantial technological barriers to autonomy remain, but overcoming them would still leave economic, political, legal, and organizational challenges to fielding significant numbers of fully autonomous aircraft in wartime situations. Clearly, the Air Force and US policy makers will consider the possibilities of autonomous aircraft and the tactical advantages that may be gained from removing pilots from cockpits. However, they must remain aware of these limitations and begin to shape Air Force organizations, policies,

and doctrines around the realities of a mixed force of manned, remotely piloted, and semiautonomous aircraft and prepare for the issues that such a force entails.

Artificial Intelligence: Always Just around the Corner

The basics of air-to-air combat are largely an algorithmic function. Junior pilots are trained extensively on basic fighter maneuvers to emphasize mastery of the textbook procedures.[7] If future air combat closely mirrors the tactics and proficiency levels we assume today, it is conceivable that programmers could develop an automated system to identify the threat environment and execute preprogrammed maneuvers based on the inputs, much as a junior pilot would. This program would be complex, significantly more so than similar decision-matrix programs for autonomous flight-route programs in other RPAs such as Global Hawk. Enabling the kind of autonomous operations envisioned by Byrnes would demand significant leaps forward in the field of artificial intelligence (AI), allowing future UCAVs to become learning entities that can adapt to circumstances and develop new tactics to overcome an adversary.

This issue is the first major challenge to autonomous UCAVs from a theoretical standpoint because the prospects for the level of AI for such a requirement are consistently overestimated. A brief review of the literature of AI suggests that since the 1940s, both experts and amateurs have perpetually viewed the prospect of AI lying a generation away (roughly 16–20 years).[8] Advancements in memory, computing power, and dynamic programming techniques over the years have increased this sense that we are on the verge of a major breakthrough, but with each breakthrough we have also seen to an extent the complexity of true AI. The examples cited by Byrnes, most prominently the 2010 article by James S. McGrew and his coauthors on the application of approximate dynamic programming to air combat, are indeed examples of advancements in computer technology that give the impression of AI but remain the execution of programs and calculations applied to specific scenarios.[9] We may indeed be on the brink of a major breakthrough that will enable near-human AI in the future, but placing a projection for a time window based on the examples cited is questionable, given the history of AI projections.

Although the ability to run programs that calculate more efficient outcomes creates the impression of AI, the aircraft is ultimately tied to a large data set of preprogrammed options and runs a decision-making process. Theoretically, this process could be built to an extreme degree whereby all possible maneuvers and assumptions about terrain, weather, and adversary logic are programmed, allowing the computer to better access likely outcomes and make decisions; however, that is a fundamentally different dynamic than a true learning process. Preprogrammed assumptions and design limitations ultimately frame the sphere in which the computer makes its decisions while a human operator can access information from a variety of additional sources that may or may not be programmed. Moreover, instincts—although fallible in a number of circumstances—can make the difference in attaining victory in close combat.[10] The assurance we have that the tactical environment will mirror our preconflict notions of air tactics will dictate our confidence in relying on technology alone to secure victory.

In a sense, this issue mirrors in the information age the problems presented by "scientism" throughout the industrial age. *Scientism*, a term of more recent origin, describes the movement from the 1700s forward that views the natural sciences as the source of all human knowledge and seeks to apply those lessons to all human endeavors.[11] In the military sphere, this perspective manifested itself through what might be called the Jominian school of strategy, which values rules of war and prescriptive approaches to conflict. As Christopher Bassford notes, Jomini saw the wars in which he participated as "the technical near-perfection of a fundamentally unchanging phenomenon, to be modified only by superficial matters like the list of *dramatis personae*, technology, and transient political motivations."[12] Conversely, Carl von Clausewitz said of the Jominians, "They aim at fixed values; but in war everything is uncertain, and calculations have to be made with variable quantities."[13] Approximate dynamic programming represents to a large degree a reaction to this critique since pure dynamic programming would be impossible, given the complexity of the operating environment. Even so, many of the approximations made in the program must be programmed in advance of conflict. Without a true leap forward in AI, reliance on extending approximate dynamic programming as the backbone of autonomous air-to-air operations would be a significant gamble in many scenarios for the foreseeable future.

Retaining the human element for remote operations in a supervisory role will thus prove necessary from a technological standpoint for the near future. Indeed, one of the long-standing concerns for the RPA community has been the failure to distinguish between remote control and autonomy. Both are at work in modern RPAs, but automation is generally limited to routine flight operations and issues such as maintaining aircraft control in lost-communications situations. Automating the release of weapons is a greater challenge, not only from a technological standpoint but also from a legal and normative one. Some precedents exist for such operations under human supervision that can be extended to offensive air operations over time, but despite these precedents, the prospect of fully autonomous air-to-air warfare remains low due to obstacles beyond technology. Overcoming them is likely to entail costs well beyond those of existing systems.

Cost Considerations for Remotely Piloted Aircraft and Unmanned Combat Aerial Vehicles

A common strain in the RPA/UCAV debate is that each will revolutionize warfare because of its low cost per unit and the ease of employing off-the-shelf technology. This is true to some extent for the near term, but as RPAs and UCAVs grow as weapons of war and as countermeasures proliferate, the costs associated with specialization will increasingly raise those of UCAVs—just as the costs of aircraft have risen with advancing technology.[14] Further, economic expenses alone do not define the outlay associated with new technologies in war. Political costs are also a consideration insofar as more reliance on technological solutions projects lower commitment to conflicts, potentially escalating the level of violence should an adversary believe he can wait out the threat of attack.

US experience with RPAs to date illustrates the problems with the standard narrative that they are cheap. Analysts often compare the Predator or Reaper to the F-22, noting that "for the price of one F-22 . . . you can buy 85 Predators."[15] By doing so, they omit the clear mission and capabilities distinctions between the Predator and the Raptor, ignoring the prospect of procuring manned aircraft tailored to perform similar missions to the Predator's. (For a better comparison, note the MC-12 Liberty program as an approximation of the RQ-1 [unarmed] Predator.) As the military has invested in newer and more capable RPAs, the cost has steadily risen to levels comparable with manned alternatives (table 1).[16] Not included in this table are the Navy's X-47, with a program cost to January 2012 of $813 million; the often-named manned alternatives such as the U-2 for the Global Hawk; or the aforementioned F-22. The U-2/Global Hawk debate is especially illustrative, given that for much of the past decade, the Global Hawk was more expensive than the U-2 (table 2), and many critics of the transition to Global Hawk see a trade-off of capabilities for cost. The Air Force itself has hedged the cost-savings argument for UCAVs versus manned equivalents, noting in the *Unmanned Aircraft Systems Flight Plan, 2009–2047* that the RPA's/UCAV's virtue lies in "increasing effects while *potentially* reducing cost" (emphasis added).[17] Given the nature of recent spending on research and development and the number of systems that advanced UCAVs would have in common with fifth-generation fighters and beyond, cost savings are likely to be in the range of percentages rather than orders of magnitude.

Table 1. Comparative costs of RPAs

	Raven	*Global Hawk*	*Predator*	*Gray Eagle*	*Predator B Reaper*	*Predator C Avenger*
Operational	2004	2000	1994	2009	2001	Flight Test
Cost	$34,000/aircraft $300,000/ system	$46.4M–$80M/ aircraft (multiple variants)	No longer in production	$4.33M/ aircraft	$11.38M/ aircraft	$35M/aircraft
Role	Low-altitude tactical intelligence, surveillance, and reconnaissance (ISR)	Near-real-time high-resolution ISR, persistent maritime ISR	ISR, targeting, forward air control, laser designation, weapons delivery, battle damage assessment	ISR, targeting acquisition, and attack	Multimission attack RPA	Quick-response armed reconnaissance
Max Altitude	500 ft.	65,000 ft.	25,000 ft.	29,000 ft.	50,000 ft.	50,000 ft.
Max Endurance	90 min.	36 hrs. (24 on station)	40 hrs.	25 hrs.	27 hrs.	18 hrs.

Table 1. Comparative costs of RPAs (*continued*)

	Raven	*Global Hawk*	*Predator*	*Gray Eagle*	*Predator B Reaper*	*Predator C Avenger*
Max Speed	44 knots true airspeed (KTAS)	340 KTAS	120 KTAS	167 KTAS	240 KTAS	400 KTAS
Weapons Payload	N/A	N/A	2 Hellfire missiles	4 Hellfire missiles	14 Hellfire or 4 Hellfire and 2x GBU-12 or 2 Joint Direct Attack Munitions	3,500 lb. internal payload, six external hardpoints

Sources: "RQ-11B Raven System," fact sheet, US Air Force, accessed 11 January 2013, http://www.avinc.com/downloads/USAF_Raven_FactSheet.pdf; Joakim Kasper Oestergaard, "About the RQ-4B & MQ-4C," Aeroweb, 4 November 2014, http://www.bga-aeroweb.com/Defense/RQ-4-Global-Hawk.html; "Predator UAS," General Atomics Aeronautical, accessed 11 January 2012, http://www.ga-asi.com/products/aircraft/predator.php; "Gray Eagle UAS," General Atomics Aeronautical, accessed 13 January 2012, http://www.ga-asi.com/products/aircraft/gray_eagle.php; "Predator B UAS," General Atomics Aeronautical, accessed 11 January 2013, http://www.ga-asi.com/products/aircraft/predator_b.php; "Predator C Avenger UAS," General Atomics Aeronautical, accessed 11 January 2013, http://www.ga-asi.com/products/aircraft/predator_c.php; and Joakim Kasper Oestergaard, "About the RQ-11 Raven," Aeroweb, 23 October 2014, http://www.bga-aeroweb.com/Defense/RQ-11-Raven.html. Regarding Predator C, cost is for aircraft estimate. Most reporting suggests it will cost three times the amount of the Predator B. See "Naval Air: Predator C at Sea," StrategyWorld, 17 August 2009, http://www.strategypage.com/htmw/htnavai/20090817.aspx.

Table 2. Comparative costs of the U-2 and RQ-4

	Procurement Cost	*Flight-Hour Cost*
U-2	Classified/no longer in production	$31,000
Global Hawk (2010)	$46.4–80 million	$40,600
Global Hawk (2013)	$46.4–80 million	$18,900

Sources: Michael Hatamoto, "USAF Hopes U-2 to Global Hawk Transition Done in 2015," DailyTech, 13 August 2011, http://www.dailytech.com/USAF+Hopes+U2+to+Global+Hawk+Transition+Done+in++2015/article22425.htm; and Andrea Shalal-Esa, "Cost of Flying Northrop's Global Hawk Down over 50% Sources," sUAS News, 14 September 2013, http://www.suasnews.com/2013/09/25052/cost-of-flying-northrops-global-hawk-down-over-50-sources/.

Beyond these economic expenses, the political costs will weigh heavily on states employing RPAs and UCAVs. Writing about RPAs in 2000, Tom Ehrhard noted that "the unmanned attack communicates shallow commitment, even fecklessness."[18] For a state, such as the United States, reliant on a series of alliance structures, this dynamic poses challenges to the Air Force beyond accessed tactical performance of technology. It raises issues of alliance assurance and the ability of advanced RPAs to convince allies of US commitment in a manner similar to that of a deployment of a fighter squadron or strategic bomber. Beyond deterrence, their actual use in contested airspace has arguably shown the net results of RPAs as a negative for states deploying them too aggressively. Despite numerous predictions that RPAs could exacerbate conflict by undermining sovereignty and allowing states to violate airspace with impunity (a charge often leveled against the United States for its RPA campaigns), experience to date has largely been the opposite. RPAs regularly have been shot down in potential conflict zones like Israel, Azerbaijan, and Georgia, and most

negative attention focuses on those employing these platforms. In the run-up to the 2008 Russia-Georgia conflict, four Georgian RPAs were shot down. If they had been manned aircraft, the international condemnation of Russia probably would have been significantly higher. Since they were RPAs, though, both Russia and Georgia were condemned by the UN investigation—Russia for the illegal shoot down and Georgia for aggravating the crisis by flying the aircraft.[19] In this case, the use of RPAs may have weakened Georgia's military posture in the run-up to the August 2008 conflict both by showing weak resolve and by coming at the economic cost of four advanced RPAs, each valued at approximately $2 million.

The need for the tactical advantages provided by future RPAs and UCAVs must be weighed against the probable remaining technical limitations; must be structured within the existing parameters of the laws of war that emphasize the responsibility of actors to control and ultimately be responsible for the application of force within a war zone; and must be evaluated in terms of the strategic costs that come in both political and economic forms. These considerations will ensure a balance of both manned and remotely piloted platforms for the foreseeable future of air warfare, with the relative proportions of semiautonomous UCAVs, RPAs, and manned platforms shifting throughout phases of the conflict.

For the near future, both technological limitations and cost restrictions appear to place autonomous warfare beyond the limitations of military planners. However, even if financial and technological barriers to such operations declined, given new technological innovations on those fronts, significant obstacles to employing such autonomous weapons in a number of wartime environments on a large scale would still remain. The laws and ethics of such warfare and the challenges of leadership and control in such an environment would pose as great a hindrance to state employment of autonomous weapons as these technological barriers.

Laws of War and Autonomous Operations

As Charles Tilly once said, "War made the state, and the state made war."[20] As commonly understood by Western nations, war is an act of states against other states. It is at its most fundamental the imposition of state will by force and coercion to achieve political ends.[21] Politics governs the use of force in war, limits the scale and scope of combat operations, and makes the state responsible for the conduct of those who act on its behalf. This principle of state control of force is essential to the framework of limiting the horrors of war and has remained constant through centuries of warfare.[22] Technological innovations of the information era do not alleviate state responsibility; instead, they present new challenges about keeping the use of technology under the control of the state and holding it responsible for its armed forces should the state choose to employ autonomous actors.

The just war tradition, codified in *jus ad bellum* and *jus in bello*, serves as the baseline for both formal and customary international law regarding the conduct of war and participants. *Jus ad bellum* represents a set of principles designed to limit the horrors of war by providing justification for military action, defining the scope of conflict, and ideally laying the groundwork for reestablishing peace at the end of

hostilities. These criteria have been refined over the years through both philosophy and codification in international law, today described generally as having just cause, being a last resort, being declared by a proper authority, possessing right intention, having a reasonable chance of success, and having the end proportional to the means.[23] *Jus in bello* is generally summarized by two criteria: discrimination and proportionality.[24] Underlying the just war criteria is the notion of responsibility, both of states and actors, for the initiation and conduct of war. RPAs and future UCAVs present a series of issues for both aspects of just war tradition, many of which can be normalized within the existing framework of international law but require greater public discussion and knowledge of RPA operations and potential actions by UCAVs.

The main challenge for RPAs in current campaigns is not one of *jus in bello* as often portrayed with a focus on disproportionality and collateral damage but a problem of *jus ad bellum* with ambiguity surrounding the question of whether operations outside campaigns such as Iraq and Afghanistan meet the just war criteria. If so, should they be evaluated by wartime understandings of discrimination and proportionality (codified under international humanitarian law), or if they are extrajudicial actions outside a war zone, should they thus be evaluated under international human rights law? The position of the US government since September 2001 has been that the campaign against al-Qaeda and its affiliates represents a noninternational conflict (a war of a state against a nonstate actor). However, the ambiguity surrounding the proper authority to expand the conflict to new states and the absence of a public declaration of both the zones of conflict and the objectives of the operation leave these conflicts in a legal gray area. Consequently, proponents and opponents of RPA operations talk past each other on the legal rationale for operations, and the United States finds itself at a disadvantage to exploit the tactical gains of operations for strategic effect by not openly discussing the targets of operations and mounting an effective information campaign.[25] The legal problem here, however, rests in the character of the conflict within international law as opposed to the tool employed. Similar criticism of special operations and manned aircraft exists.[26] The RPA receives the most attention because it represents a new technology and because it can make such interventions more common in uncontested airspace.

UCAVs in a traditional international conflict raise a different set of concerns for international law, primarily stemming from the overarching issue of responsibility. International law has codified responsibility both for individual actors and for the states employing such vehicles to varying degrees over time, with an increased emphasis on holding individuals accountable for their actions. Ultimately, however, the state remains responsible for the conduct of its armed forces, and states have historically held the military responsible through the process of commissioned officers. An officer's commission is given in the name of the head of state to act in his or her name overseeing the armed forces, based on demonstrated loyalty to the state and trust in the integrity and leadership of the commissioned officer. This principle was explicitly codified in the Hague Convention of 1899 and 1907, which declares in Article 1 of Annex 1 that "the laws, rights, and duties of war apply not only to armies, but also to militia and volunteer corps fulfilling the following conditions: To be commanded by a person responsible for his subordinates."[27] A fully autonomous

UCAV, at minimum, must retain this requirement for positive control by the operating state. How to do so is to an extent an open question, but existing examples of automatic/autonomous operations suggest that the answer already exists for some environments.

Human Rights Watch, a group that regularly addresses the issue of robotics and warfare, may have inadvertently opened the door for the legal use of robotic weapons through its differentiating existing automated lethal systems from potential future "killer robots" that would be wholly autonomous. In addressing the move toward automation in 2012, Human Rights Watch examined "automatic weapons defense systems" such as the Phalanx or Israel's Iron Dome as a step in the direction of automation but something that remained fundamentally different, being "automatic" versus "autonomous." Human Rights Watch says these weapons systems deserve further scrutiny because of their existing potential for collateral damage and because of concerns about the actual level of human control over the system. On balance, though, the distinction between automatic systems and autonomous systems appears acceptable.[28] If, however, an "automatic" system such as the Phalanx is acceptable, then a similar airborne network of defensive UCAVs to secure permissive airspace would similarly prove acceptable by the same logic. This concept could be taken to the next stage to permit offensive operations in a pure air-to-air environment given human control, either from ground stations or forward airborne control into denied environments—the essence of the "swarm and cloud."[29] The key issue becomes the level and character of human control of the network of UCAVs and the ability to hold both officers and the state accountable for the use of military force.

Outside these environments, as the challenges of discrimination rise, so does the need for higher levels of human supervision. Current international law and the political realities that frame any conflict are likely to dictate this scenario even if it can be shown that new technologies such as visual identification can better identify and target in wartime than a human counterpart. Both the policy makers responsible for the overall conduct of their forces and the populations supporting the war effort are unlikely to delegate decisions that can result either in a criminal action or the unintended escalation of conflict without the prospect of an individual or individuals responsible for and held accountable for the decision. A machine, without self-awareness, cannot fill that role.

Two major factors are thus at work in determining the overall balance of remotely piloted platforms versus manned platforms. The first is the threat posed to aircraft by adversary fighters and other defensive networks (surface-to-air missiles, electronic and cyber attack, etc.), and the second is the ability to discriminate between military and nonmilitary targets. In a hypothetical conflict against a near-peer competitor, the early phases of conflict will likely be dominated by high-intensity conflict in which discrimination is relatively easy—especially in the air-to-air environment—and the threat is very high. Over time, this balance shifts—more so for air assets than ground assets—since attaining air superiority reduces the threat while the progress of bombing campaigns makes target discrimination increasingly difficult. Within the category of RPAs, a shift will also probably occur from semiautonomous UCAVs toward RPAs as the air threat dissipates and the problems of ground-target discrimination

increase. The figure below offers a conceptual model for the relationship of manned to remotely piloted airframes across the major phases of conflict, including two mirroring S curves that represent the change in the air threat environment and the matter of target discrimination. Semiautonomous UCAVs face a higher requirement proportional to the level of the air threat, and persistent RPAs are necessary once the air threat is minimized while ground targets are most elusive. Manned airframes are required in all phases, playing the greatest role in phases two and three, when airspace is contested but semipermissive and the primary air-to-ground effort concentrates on both fixed targets and conventional military forces.[30]

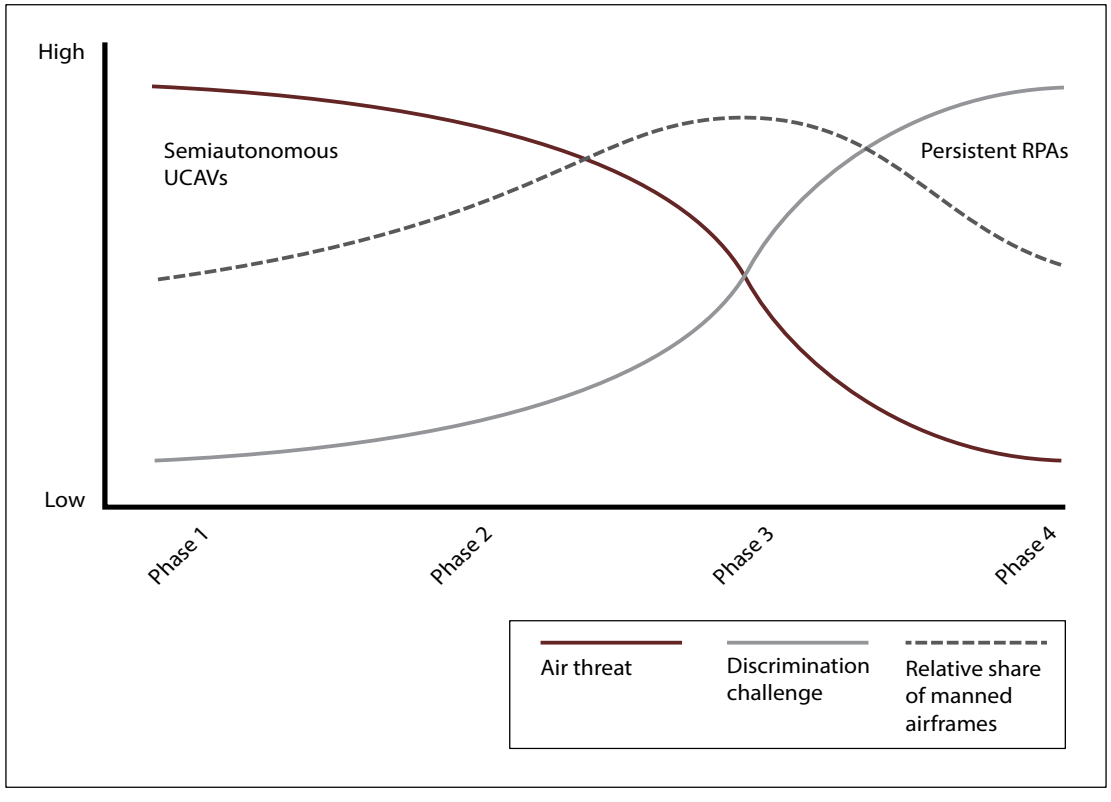

Figure. Estimated share of manned airframes across phases of conflict

Future Challenges for the Air Force

RPAs and UCAVs present significant concerns for the military services that employ them insofar as their use directly confronts the essence of what it means to be a war fighter and the relationship of combat effects to traditional ideals of warfare marked by individual heroism and sacrifice. The US military has had significant issues with this matter recently, both with the questions of promotion rates for RPA

pilots and with the debate over the Distinguished Warfare Medal. At issue in this dispute is the role of technology in shifting the relationship of proximity to harm to combat effects and with it the very nature of what it means to be involved in "combat operations." If organizations wish to continue adopting innovations, they must find ways to recognize and promote individuals proficient in these new systems of war, a prospect that represents a greater challenge than quotas or protection of specific career fields. It will demand a fundamental reevaluation of who we are as a service and what it means to be an Airman, compared to the traditional understanding of what it means to be a warrior.

Development of a strong career progression system is vital to the normalization of new technologies and practices within an organization because, as Stephen Rosen notes, innovation occurs "only as fast as the rate at which young officers rise to the top."[31] The issue of promotion ceilings and the integration of new technologies into the armed forces is not a new phenomenon. Billy Mitchell identified promotion ceilings for pilots in 1925 as one of the key justifications of an independent Air Force because such restrictions would be devastating to the development of strategic airpower: "The personnel situation is very serious in all the air services. . . . Their position on the promotion list is hopeless. Some of our lieutenants can never rise above the rank of major or even captain. They see no future before them and consequently are not in the state of mind in which officers in so rapidly developing a service should be."[32] The existing Air Force organizational structure presents a series of challenges to the normalization of RPA culture within the service as increased visibility of a "glass ceiling" for RPA pilots has grown in the past year. Part of this situation proceeds from existing perceptions of RPAs within the Air Force flying community and the process of rapid expansion of the RPA community; another part is rooted in requirements the Air Force places on command position eligibility.[33] The first issue to rise to the attention of both the public and lawmakers (emerging in 2012) was the reported lower promotion rate of RPA pilots compared to that of traditional Air Force pilots.

Closely related to the issue of promotions is recognition. Debate over the Distinguished Warfare Medal is illustrative. The potential recognition of RPA operators with decorations rating above the Bronze Star Medal with "V" resulted in a significant backlash both within and without the Air Force. John Soltz, chairman of VoteVets, a political action committee for veterans, summarized this argument: "I personally don't have an issue with the medal itself. Troops don't set the policy; they just perform their duties. . . . What I do have an issue with is this: The new medal ranks above the Purple Heart. For those who served, that doesn't sit right."[34] Similar arguments were raised by the Veterans of Foreign Wars, the American Legion, and numerous other veterans in editorials.[35] If we accept this framing—that medals represent heroism and that no nonvalor awards should take precedence over valor awards—and if we took the next step that the awards process was independent of the promotion process, this position would be completely valid. However, neither of those conditions is true under the current system.[36] As a result, the failure to recognize those who produce greater operational effects creates a potential disconnect between whom the service promotes and who is a capable, modern war fighter. Heroism and the broader warrior ethos are closely connected to operational effects under a traditional ground

operation—and even for tactical airpower—but not necessarily for strategic airpower and war at a distance.

Since 2001 the Air Force has sought to recenter the force around the "warrior ethos" and the tenets of the "Airmen's Creed," both of which emphasize the traditional values of being a "warrior," dating to the Spartan ethos. Steven Pressfield examined the common understanding of the warrior ethos at length in 2011 when he wrote a volume dedicated to members of today's military that discussed the origins of that ethos.[37] To Pressfield, the warrior ethos emerges from a sense of fear on the battlefield, where classic war was fought hand to hand and between roughly equivalent armed forces: "For a Greek or Roman warrior to slay his enemy, he had to get so close that there was an equal chance that the enemy's sword or spear would kill him. This produced an idea of manly virtue. . . . The ancients resisted innovation in warfare because they feared it would rob the struggle of honor. . . . The God who ruled the battlefield was Phobos, fear."[38] Courage and honor represent essential elements of the warrior ethos, which manifests in the Army's ethos as a subset of the drive for victory and the obligation of never leaving a man behind.

The Air Force, from its beginnings, recognized that it was something different. Both Mitchell and Giulio Douhet saw the virtue of the air weapon as its ability to bypass this type of combat and take the fight directly to the adversary with no hope of defense. Douhet, at the most extreme, saw this as completely overturning existing norms of war, eliminating the distinction between militaries and civilians and shattering traditional notions of war and the warrior ethos.[39] Mitchell, while less absolute than Douhet in a number of aspects, echoed a similar theme: "An entirely new method of conducting war at a distance will come into being. . . . As air power can hit at a distance, after it controls the air and vanquishes the opposing air power, it will be able to fly anywhere over the opposing country."[40] This, in turn, Mitchell noted, led to a very different perspective of warfare for airmen versus other combatants: "The air-going people have a spirit, language, and customs of their own. They are just as different from those on the ground as those of seamen are from those of land men."[41] Though bravery and valor remain essential to gaining and maintaining control of the sky, Mitchell and Douhet both saw airpower's main value as the ability to attack at will against an undefended enemy after seizing command of the air. This vision of airpower as unrestricted, combined with the realities at various points in our history of the tactical difficulties of gaining air superiority, has led to some of the greatest organizational problems over time. To varying degrees, bomber and missile forces have embraced Mitchell's vision, which, during the Cold War, often proved detrimental to tactical proficiency and the warrior spirit of tactical engagement. The rise of the fighter-pilot generals beginning in the late 1980s, followed by the challenges of air campaigns in the Balkans and the Middle East, moved the Air Force back in the direction of a more tactical warrior mind-set. Indeed, after 2001 the Air Force was dominated by this perspective that emphasized the traditional values of a warrior over technocratic skills.[42]

The debate over a future of autonomous UCAVs dominating air warfare versus a moral argument against automation represents only the most recent fault line in this ongoing dialogue. Rather than picking winners between rival factions, the organizational goal must be eliminating destructive competition between the factions and

refocusing on the larger mission and the tools necessary to carry it out. Doing so will at first involve changing the way we promote and recognize individuals but ultimately must go to the question of what the service really does—deterring and defeating threats to the United States and its interests through the control and exploitation of air, space, and cyberspace. Everything else the service does is a means to this end—not the end itself. Technology will serve as a vital force multiplier, but ultimately war is a contest of people and ideas, with organizations and tactical innovations playing the decisive role in attaining military objectives. Building systems to support innovation and create leaders positioned to capitalize on those innovations must be the greater concern today, rather than the specifics of the tactics employed. The argument must not pit technocrat versus warrior but must leverage the virtues of both to meet the challenges of future conflicts.

Conclusion

From its earliest era, airpower has envisioned a future in which promising new technologies can solve such age-old matters as the fog and friction of war and the swift and decisive domination of a military adversary. To this point, the history of air warfare has shown that, as technologies advanced toward fulfillment of that vision, new obstacles in both technology and the fundamental human nature of conflict remain. The debate over the future of RPAs and UCAVs in warfare represents but the latest in a string of airpower technologies that can significantly increase military capabilities but that will be insufficient by themselves to solving human conflict. Technological barriers to true artificial intelligence, economic and political costs, leadership and organizational obstacles to effectively controlling autonomous operations, and the legal and ethical demands of warfare are likely to ensure a significant role for manned operators and support infrastructure in air warfare for the foreseeable future. The future of the Air Force does not involve a race to or from autonomy but the question of how the organization can integrate manned flight, RPAs, and UCAVs into a single force that maximizes combat power.✪

Notes

1. The Hague Convention of 1907 banned bombardment "of towns, villages, dwellings, or buildings which are undefended." However the ill-defined word *undefended* led to a loophole, allowing bombing in most cases as long as the state was resisting and had some means of defending itself through an armed force. "Laws of War: Laws and Customs of War on Land (Hague IV); October 18, 1907," Art. 25, Yale Law School, accessed 12 May 2014, http://avalon.law.yale.edu/20th_century/hague04.asp.

2. Giulio Douhet in particular underestimated both the cost and number of munitions required to inflict the level of damage postulated by his theories. See Philip Meilinger's summary of Douhet for a more detailed account of his theories and calculations. Col Phillip S. Meilinger, "Giulio Douhet and the Origins of Airpower Theory," in *The Paths of Heaven: The Evolution of Airpower Theory*, ed. Col Phillip S. Melinger (Maxwell AFB, AL: Air University Press, 1997), 1–40.

3. See, for example, P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-First Century* (New York: Penguin Press, 2009); Medea Benjamin, *Drone Warfare: Killing by Remote Control* (London: Verso, 2013); and Nick Turse and Tom Engelhardt, *Terminator Planet: The First History of Drone Warfare* (n.p.: Dispatch Books, 2012).

4. Tabassum Zakaria and David Alexander, "Weapon of Choice against al Qaeda, Drones Marginal in Syria," Reuters, 4 September 2013, http://www.reuters.com/article/2013/09/04/us-syria-crisis-drones-idUSBRE98314C20130904?feedType=RSS&feedName=worldNews.

5. Denise Garcia, "The Case against Killer Robots: Why the United States Should Ban Them," *Foreign Affairs*, 10 May 2014, http://www.foreignaffairs.com/articles/141407/denise-garcia/the-case-against-killer-robots.

6. Maj David J. Blair and Capt Nick Helms, "The Swarm, the Cloud, and the Importance of Getting There First: What's at Stake in the Remote Aviation Culture Debate," *Air and Space Power Journal* 27, no. 4 (July–August 2013): 14–38, http://www.airpower.maxwell.af.mil/digital/pdf/articles/Jul-Aug-2013/F-Blair.pdf; and Capt Michael W. Byrnes, "Nightfall: Machine Autonomy in Air-to-Air Combat," *Air and Space Power Journal* 28, no. 3 (May–June 2014): 48–75, http://www.airpower.maxwell.af.mil/digital/pdf/articles/2014-May-Jun/F-Byrnes.pdf. As the terms appear in this document, *RPAs* and *UCAVs* represent ideal definitions on a spectrum of human control. RPAs remain under the control of a human operator and manned reachback infrastructure with similar human inputs to operations that existing manned airframes require. UCAVs, in contrast, operate with limited supervisory autonomy and can conduct strike missions with minimal direct human intervention. RPAs and UCAVs can be further differentiated by generational differences in aircraft design and survivability similar to differences in generations of fighters. RPAs generally consist of basic airframes designed to operate in permissive environments, and UCAVs incorporate advanced designs and stealth technologies to improve survivability in contested environments.

7. Thanks to Dave Blair for this phrasing.

8. For a good summary of the literature, see Stuart Armstrong's blog *Less Wrong*, which examines 257 total AI predictions and 95 with timeline predictions for "human-level" AI. Of this survey, over one-third of both experts and amateurs consistently predicted AI within 15–25 years, dating to the 1940s. Stuart Armstrong, "AI Timeline Predictions: Are We Getting Better?," *Less Wrong*, 17 August 2012, http://lesswrong.com/lw/e36/ai_timeline_predictions_are_we_getting_better/.

9. James S. McGrew et al., "Air Combat Strategy Using Approximate Dynamic Programming," *Journal of Guidance, Control, and Dynamics* 33, no. 5 (September–October 2010): 1641–54, http://dspace.mit.edu/openaccess-disseminate/1721.1/67298.

10. This is closely related to deductive versus inductive reasoning but imprecise, given the context.

11. Thomas Burnett, "What Is Scientism?," American Association for the Advancement of Science, accessed 13 May 2014, http://www.aaas.org/page/what-scientism.

12. As Bassford and others have noted, Antoine-Henri Jomini himself would likely reject the caricature of his work, which in total is very similar to Clausewitz's though they are often portrayed as writing contrasting positions on the essence of warfare. The distinctions between the two listed here represent a small fraction of the overall work of these theorists but generally describe how they are remembered in the realm of military theory. Christopher Bassford, "Jomini and Clausewitz: Their Interaction," Clausewitz Homepage, 26 February 1993, http://www.clausewitz.com/readings/Bassford/Jomini/JOMINIX.htm.

13. Ibid.

14. I limit this article largely to the use of RPAs by state actors, but factors that will raise the cost of RPAs for states will likely be a greater obstacle for nonstate actors. Small RPAs made from off-the-shelf technology are likely to play an intelligence, surveillance, and reconnaissance role and a limited tactical attack role by nonstate actors. However, as countermeasures are developed and mechanisms to prevent their ability to act in close coordination though "swarm" tactics develop, in the long run this risk will be less than is often predicted. Weaponizing RPAs will add significant weight and increase their size to the point where their utility declines as costs and vulnerabilities increase.

15. Singer, *Wired for War*, 33. See also Michael C. Horowitz, *The Diffusion of Military Power* (Princeton, NJ: Princeton University Press, 2011), 221.

16. Beyond platform costs, a common question that arises is whether life-cycle costs end up lower due to lower training costs and other related issues. This is difficult to quantify at the present time because as some life-cycle costs are lower, the remotely piloted factor of RPAs has led operators to risk the airframes in many situations, resulting in higher loss rates, particularly with tactical RPAs employed by the US Army. Future studies will have to better answer this question as operational use increases

and greater numbers of cases become available. Regardless, the open question suggests that any potential cost gains are likely to be low if at all—and not in orders of magnitude.

17. Quoted in W. J. Hennigan, "New Drone Has No Pilot Anywhere, So Who's Accountable?," *Los Angeles Times*, 26 January 2012, http://articles.latimes.com/2012/jan/26/business/la-fi-auto-drone-20120126.

18. Thomas P. Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation" (diss., Johns Hopkins University, 2000), 628.

19. According to the UN Observer Mission in Georgia report, "A reconnaissance mission by a military aircraft, whether manned or unmanned, constituted 'military action' and therefore contravened the Moscow Agreement. . . . However legitimate this purpose may seem to the Georgian side, it stands to reason that this kind of military intelligence-gathering is bound to be interpreted by the Abkhaz side as a precursor to a military operation, particularly in a period of tense relations between the sides." "Report of UNOMIG [UN Observer Mission in Georgia] on the Incident of 20 April Involving the Downing of a Georgian Unmanned Aerial Vehicle over the Zone of Conflict," 26 May 2008, http://globe.blogs.nouvelobs.com/media/01/02/cf530afbef0fb6f305824428f6c83509.pdf.

20. Charles Tilly, ed., *The Formation of National States in Western Europe* (Princeton, NJ: Princeton University Press, 1975), 42.

21. Force and coercion in this context refer to the definitions used by Thomas Schelling, who differentiates between "brute force" (the decimation of the enemy) and "coercion" (violence and threat of further violence, both deterrence and compellence) as parts of a bargaining process. Thomas C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 1966), 5–7, 66–70. Clausewitz is famous for noting that it is the "continuation of politics by other means," but more specifically he defined it as "an act of force to compel our enemy to do our will." Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 75.

22. At the same time state control is vital from a legal perspective to control violence in conflict, one could view the passions of the era of nationalism from Napoleon through at least World War II as exacerbating violence in a number of cases as rational control breaks down.

23. Alexander Moseley, "Just War Theory," *Internet Encyclopedia of Philosophy*, accessed 21 January 2014, http://www.iep.utm.edu/justwar/.

24. Ibid.

25. See Johnston and Sarbahi's work on the military effectiveness of RPAs for an example of how these platforms have had limited but demonstrated tactical success while the strategic impact remains ambiguous. Patrick B. Johnston and Anoop K. Sarbahi, "The Impact of U.S. Drone Strikes on Terrorism in Pakistan," 11 February 2014, http://patrickjohnston.info/materials/drones.pdf.

26. For an example of the criticism extending beyond RPAs, see Jeremy Scahill, *Dirty Wars: The World Is a Battlefield* (New York: Nation Books, 2013).

27. "Laws of War," Annex 1, Article 1.

28. "Losing Humanity: The Case against Killer Robots," Human Rights Watch, 19 November 2012, http://www.hrw.org/reports/2012/11/19/losing-humanity.

29. This could range from a modified F-22 to a larger command post such as an E-3, with the pilot role of the F-22 shifting from direct air-to-air combat toward an air-battle-manager role for a team of UCAVs operating at a distance.

30. The need for continued, elevated high autonomous aircraft in phase two may remain, depending on the progression of automation in the air-to-air environment.

31. Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca, NY: Cornell University Press, 1991), 105.

32. William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (New York: G. P. Putnam's Sons, 1925), xviii.

33. For further information, see Lt Col Lawrence Spinetta's work examining the "glass ceiling" for RPA pilots. Lt Col Lawrence Spinetta, "The Glass Ceiling for Remotely Piloted Aircraft," *Air and Space Power Journal* 27, no. 4 (July–August 2013): 101–18, http://www.airpower.au.af.mil/digital/pdf/articles/Jul-Aug-2013/V-Spinetta.pdf.

34. Jon Soltz, "The New Drone Medal and Why Troops Need Hagel," *Huffington Post*, 21 February 2013, http://www.huffingtonpost.com/jon-soltz/the-new-drone-medal-and-w_b_2734731.html.

35. See, for example, John Bruhns, "Why the Drone Medal Is Overvalued," *Huffington Post*, 25 February 2013, http://www.huffingtonpost.com/sgt-john-bruhns/why-the-drone-medal-is-overvalued_b_2756375.html.

36. Retired colonel Terry Stevens, an Air Force personnel officer, noted his unofficial formula for the importance of decorations in calculating the prospects of officer promotion: "Company-grade officers will normally have an Air Force Achievement Medal and a Commendation Medal or two. Majors and lieutenant colonels also should have Meritorious Service Medals and/or Joint Meritorious Service Medals, with clusters. If you do, then you've shown initiative, leadership and above-average performance." David Larter, "Officer Drawdown: What Are Your Chances?," *Air Force Times*, 10 July 2011, http://www.airforcetimes.com/article/20110710/NEWS/107100313/Officer-drawdown-What-your-chances.

37. Steven Pressfield, *The Warrior Ethos* (New York: Black Irish Entertainment, 2011).

38. Ibid., 12–13. As examples of Pressfield's central point about the relationship of innovation and the warrior ethos, major innovations of the past were described in terms of being dishonorable to the way the RPA is debated by current advocates of the warrior ethos. In the Second Lateran Council of 1139, the Catholic Church declared, "We prohibit under anathema that murderous art of crossbowmen and archers, which is hateful to God, to be employed against Christians and Catholics from now on." "Second Lateran Council (1139): Canons," accessed 15 June 2015, http://www.ewtn.com/library/COUNCILS/LATERAN2.HTM. Similarly, in the 1600s, Cervantes noted that the "devilish invention [of artillery enables] . . . a base cowardly hand to take the life of the bravest gentleman. . . . A chance bullet, coming nobody knows how or from whence, fired perchance by one that fled affrighted at the very flash of his villainous piece, may in a moment put a period to the vastest designs" J. F. C. Fuller, *Armament and History* (New York: De Capo Press, 1998), 91–92. In World War I, a French general was said to have remarked on how horrible the machine gun was because "three men and a machine gun can stop a battalion of heroes." Kirsten Cale, "Cultural Wars," Clausewitz Homepage, accessed 22 May 2014, http://www.clausewitz.com/readings/CaleReview.htm.

39. For Douhet's discussion of how he sees the aircraft revolutionizing warfare and concepts of what it means to be a combatant, see Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (New York: Coward-McCann, 1942), 8–11.

40. Mitchell, *Winged Defense*, 11, 16. Between the passages highlighted here, Mitchell details his perspective of the development of warrior cultures and eventually armies in a manner similar to that described by Pressfield but with a distinctly negative view. Airpower, he argues, fundamentally changes the calculus by tying the entire state back to conflict and not just one caste while making the fighters specialists in delivering force rather than overcoming fear.

41. Ibid., 6.

42. A casual sampling of the comments section of articles on the US Air Force's website (http://www.af.mil/), the *Air Force Times*, and controversial pieces in *Air and Space Power Journal* illustrates the fault lines in this debate: those on either extreme view themselves as either the outsider or the one losing influence. Those outside the flying community tend to see the Air Force as dominated by fighter pilots and de-emphasizing other key aspects of the service's mission. Those in the flying and maintenance community point to the current Air Force mission, arguing that they should have more influence but are steadily losing it due to a variety of reasons unrelated to the mission, from political correctness to lack of focus. The comments section for Maj Dave Blair's May–June 2012 *Air and Space Power Journal* article "Ten Thousand Feet and Ten Thousand Miles: Reconciling Our Air Force Culture to Remotely Piloted Aircraft and the New Nature of Aerial Combat" is particularly illustrative (http://www.airpower.maxwell.af.mil/article.asp?id=72).

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