Assimilating Unmanned Aircraft Systems

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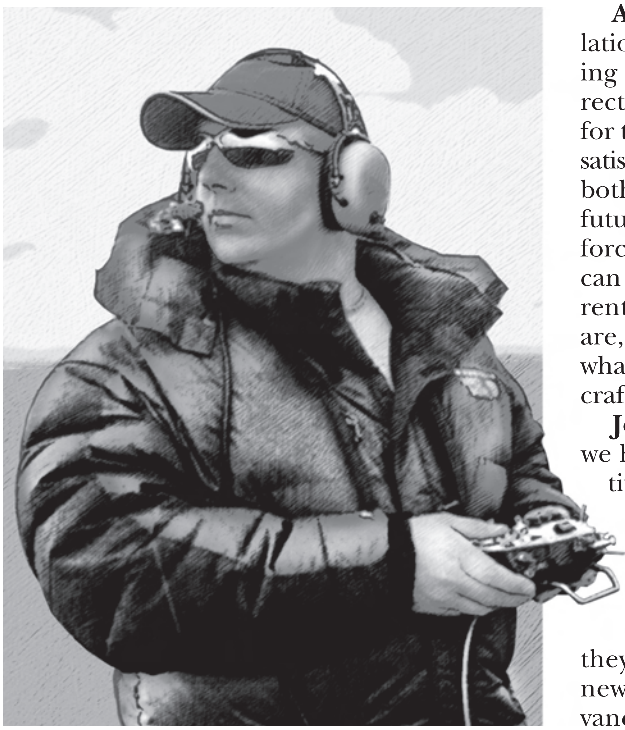
Envisioning future unmanned aircraft systems (UAS) as stand-alone weapons is not productive. As these aircraft evolve, legacy systems will advance, and enemies will simultaneously adapt. The resulting mix of future UASs and modernized legacy systems—as well as adaptive enemies—requires uniquely designed organizations, career paths, and strategies. In the following discussion, four airpower theorists and analysts consider historical lessons and current trends that might help airmen build the right combination of leaders, concepts, and institutions to realize the full potential of unmanned aircraft.



Air Vice-Marshal Tony Mason: The assimilation of UASs into national air forces is moving briskly, but in an astonishing array of directions. If there is a clear path to the future for these systems, no one has captured it to my satisfaction. Dick Szafranski and Jeffery Barnett, both of Toffler Associates, you are published futurists on airpower. Sung-pyo Hong, your air force is on a continuous war footing, so you can keep these two futurists grounded in current realities. My questions to the three of you are, "How should airmen assimilate UASs, and what is the best path to the future of these aircraft?" Jeffery, lead us off.

Jeffery Barnett: As a first principle, I think we have to remember that weapons are additive. When new weapons emerge, they add to arsenals; they seldom subtract. For example, today's soldiers don wearable computers—but they still train to kill with knives and rifle butts. Naval ships track and destroy satellites in orbit—but they still carry cannons on their decks. The new F-22 Raptor has supercruise engines, advanced avionics, and stealthy coatings—but it is still armed with a machine gun. It is a mistake to suppose that new weapons retire their predecessors. New weapons and methods *expand* the scale of war; they don't replace it. Warriors retain the weapons of the past because previous means of war making endure. The small number of weapons that fade away over time, such as sailing ships and horse cavalry, is far too few to refute the additive nature of weaponry.

Dick Szafranski: Types of war are also accretive. Conventional war did not make insurgencies obsolete. Nuclear war did not make insurgencies and conventional wars obsolete. Cyberwar will not make nuclear, conventional, and insurgent wars obsolete. Just as the Third Wave information age changed, but did not replace, the way societies manufacture and farm, so will new waves in warfare change, but not replace, humankind's previous ways of violence. Tribes will still war over land, using First Wave (agrarian age) tools; nations will still war over fuels for factories, using Second Wave (industrial age) tools; and future societies will war over cyberspace, using Third Wave (information age) tools. These three types of war—and all the other types developed by humans over millennia—will inevitably remain.[1] So when we envision future UAS operations, we have to see them in the context of all types of war.

Jeff: Your comments remind me of an interchange during the Air Force chief of staff's confirmation hearing. Senator Daniel Akaka asked Gen Norton A. Schwartz if he believed that the Air Force should continue building its counterinsurgency capabilities or if he thought that doing so would adversely affect preparations for building the future Air Force. General Schwartz replied, " 'Fundamentally, I do not believe it is an either/or condition. . . . The United States Air Force, like the other services, needs to be a full-spectrum capability. . . . The bottom line, Senator, is that we as an Air Force can provide both the kind of concentrated effort required by the joint team in Central Command today and posture ourselves for future potential adversaries at the same time.' "[2]

When it comes to unmanned systems, I think that the guidance from the chief of staff is clear—and reasonable. The US Air Force will develop UASs that integrate with the rest of the force to fight across the spectrum of conflict.

Col Sung-pyo Hong: I think that all of these points are right. Legacy weapons and types of war don't go away. They just absorb new systems to create new military effects. In fact, shouldn't we expect UASs to combine with legacy systems—to produce effects greater than the sum of their parts?

Jeff: I couldn't agree more. Just as warriors of the past integrated industrial- and agrarian-age weapons to fight over resources and land, so will future warriors integrate industrial-, agrarian-, and information-age weapons to fight over resources, land, and cyberspace. Insurgents, for example, will fuse information-age cell phones with industrial-age artillery shells to war over tribal homelands that formed in the agrarian age. They will fuse multiple means of war to produce effects that exceed the power of any single weapon or type of war.

It is the product of this fusion that modern warriors must seek to understand. With this knowledge, they can build operational concepts to master the wars of their generation, and they can develop the talents needed to command modern war as well as the tools to prosecute it. Because we need tools and talent to produce and execute new operational concepts—and because those new concepts demand particular types and numbers of tools and talent—the entire process is iterative. Militaries that seek to posture for the next war must fuse weapons, concepts, and talent in parallel.

Dick: That's the point. Today's generation of military professionals must incorporate UASs into their calculus of future war. These platforms offer revolutionary capabilities on a par with radar, jet engines, surface-to-air missiles, precision weapons, and stealth. Like these previous revolutionary capabilities, UASs will realize their full potential only when fused with legacy systems, novel concepts of operation, and innovative organizational structures.

Jeff: This fusion is easier said than done. Humans tend to use a new capability as simply an improved version of a previous capability. For example, office workers initially used personal computers as word processors. To an extent this was valid—desktop computers made an existing task (typing) easier and faster. However, desktop computers eventually inserted new functions and ways of operating into our offices. Lots of people fought this transformation for years, holding on to secretaries, refusing to allow telecommuting, and insisting that all staff work arrive in bound form. Those people slowly lost out in the competitive workplace. The lesson learned from the growth of personal computers is that although the initial change may be linear (and compatible with existing structures), the eventual effects may undermine those same structures.

Hong: In other words, understanding new technologies simply as improved versions of their predecessors has a short half-life. Can you apply this theory directly to the UASs of today?

Dick: As we fuse unmanned aircraft with legacy systems to produce new operational capabilities, we need to think of UASs as far more than just uninhabited versions of manned aircraft. Though true, this linear perspective is less and less relevant. UASs are more than just airplanes without pilots, just as cell phones are more than just phones without wires. Our challenge is to foresee where UASs will evolve in unique ways—and then build future concepts of operation and organizations accordingly.

Tony: Let me expand on your point. A need exists for more fusion than that simply between current and future weapons, concepts, and talent. At present, the structure of UAS operations is the legacy of an earlier era. It is determined by location rather than by function. Horizontally, it corresponds to the boundaries of theatres and commands. Vertically, the structure distinguishes among outer space, inner space, and atmosphere. The functions and capabilities of UASs already transcend earthly features. Satellites are unmanned systems. The new structure must reflect function—not location or propulsion. It must present a seamless fusion of netted UASs, responsive to one central executive but flexible enough to remain accessible and available at any operational level. That will require rethinking existing bureaucratic and hierarchical formations, which might prove more difficult than deploying the aircraft themselves.

Hong: This is exactly what Mr. Andrew Marshall of the Office of Net Assessment articulated in his theories on the revolution in military affairs. He said that radically new technologies required new concepts of operation and new organizational structures to realize their full potential. He also said that the first step in building concepts and organizations for the future involved projecting the realistic potential of new technologies.[3]

Dick: We can't predict the future or know what's ahead with precision, but we can project that enabling UAS technologies will continue their rapid advance. Moore's Law endures: bandwidth and computer-processing speeds continue to double every 18 months. Knowledge is now digitized, permitting the rapid sharing of cross-discipline data by billions of people. New types of sensors are spewing from the medical and security spheres. Global spending on information and communications will soon pass $4 trillion a year.[4] Individually, these trends show no signs of slowing. Viewed collectively, they promise logarithmic advances for years to come in multiple technologies enabling UASs.

Hong: If your projections prove true, the UAS of the future will have a full range of capabilities. In Korea we are beginning the debate on employing these systems in air-to-air or air-to-ground combat. Most airmen agree that UASs will eventually take part in future combat missions. Our question is, "When will this happen?" The current consensus is that UAS combat capabilities will lag behind those of manned aircraft for some time.

My personal guess is that our air force will continue to invest in manned fighters, such as the A-50 or a more capable future KFX. We will gradually increase the roles of unmanned aircraft. They will get more attention, but our UAS focus, at least for the midterm, will remain on constant surveillance and reconnaissance.

Jeff: The prospect that UASs will produce constant surveillance is profound. We have never lived in a world where potential aggressors operated under such surveillance. Consider, for a moment, Heisenberg's uncertainty principle, which theorized that the very act of observation affects the object observed.[5]

Though envisioned for physical behavior, this theory would seem to apply to organic behavior as well. If fleets of UASs can persistently observe potential aggressors and if the very act of observation can affect actions, then it follows that skillfully applied observation can have a dynamic effect on adversary nations. In essence, persistent surveillance from UASs may allow militaries to influence enemies through skilled observation.

Anyone who has shined a flashlight on bugs in the basement understands this principle. As soon as the light shines on them, the bugs start scurrying about. Illuminating the bugs changes their behavior.

Dick: Viewed in this light (sorry for the pun), it's clear that UASs will soon offer degrees of persistence unavailable to previous generations of military leaders. They will loiter in massive numbers over practically any point on the earth for days (even months) at a time. Fleets of unmanned aircraft will offer persistent intelligence, surveillance, and reconnaissance; persistent strike; and persistent logistics. These UASs will take full advantage of persistent development. The absence of a human in the cockpit allows far more aggressive and risk-intensive approaches to experimentation, production, and adaptation. An entirely new industrial base should emerge to leverage persistent development.

Jeff: This kind of persistence has strategic implications. The persistent effects made available through UASs, in concert with other joint military capabilities, open new possibilities for persistent deterrence. Nations can persistently engage with other nations—and with insurgents—for extended periods without overtasking manned systems. To meet the emerging "long war" against global terrorism (a type of persistent conflict), nations can engage persistently with UASs. They enable persistent effects against a persistent enemy—at operational tempos that militaries can sustain indefinitely.

Tony: The Heisenberg principle is well founded, and the constant observation promised by UASs may indeed allow "manipulation" of an opponent's behavior. An intelligent opponent who is aware of the threat from UASs, however, may respond with behavior that becomes more difficult to detect, identify, and anticipate. An opponent not constrained by time, unscrupulous in the exploitation of innocents, and impervious to casualties will seek new methods of concealment, deception, and duplicity to counter the observation technologies orbiting above.

Jeff: Enemies will certainly react, but their options will be limited by the scope of potential observation. Let's talk in terms of aviation history. Currently deployed UASs will soon seem as quaint as a Wright Flyer. After all, it took just 15 years for manned aviation to progress from Kitty Hawk to Billy Mitchell's 1918 St. Mihiel offensive with 1,500 Allied fighters and bombers. Within another decade, aircraft were exceeding 300 miles per hour, Charles Lindbergh had flown the Atlantic, and Robert Goddard was launching liquid-fueled rockets. Ten years after that (1938), radar was invented, the DC-3 (with autopilot) was flying coast-to-coast, and jet engines were on the test stands (the first jet-powered aircraft flew in 1939). History's lesson is that aviation technologies advance rapidly.

Hong: Putting these two thoughts together, we clearly see great potential. Aviation's inherent freedom and flexibility, combined with the global information revolution, leave no room for conservative projections of future capabilities. The UAS of 10 to 15 years from now will perform far differently than the one in development today. Given the speed of the information age and its enabling technologies, we should prepare for remarkable UAS advancements in the near future.

Jeff: All of us must avoid "old think." Consider the fact of institutional transformations. Almost 90 years ago, the United States Navy began an equally audacious transformation. The slow-moving fleet of history adopted the airplane. Although sailors accepted it at varying rates, naval leadership in 1921 set a firm course, probably with full awareness of the possible end game, by creating a single institution—within the Navy—to develop naval aviation.

The Bureau of Aeronautics combined decentralized Navy aviation organizations into a single team. It developed technologies, concepts, and personnel for naval aviation as an integrated whole. The bureau built naval aviation while simultaneously integrating its vision with parallel developments across the fleet.

Even more important than creating the bureau was selecting its initial leadership. The Navy chose its best—Rear Adm William A. Moffett, Medal of Honor recipient and battleship commander—as first chief of the bureau. He led it not only with aggressiveness but also for a remarkably long time—12 years (until he died during the crash of the airship *Akron* in 1933). Moffett had the credibility and longevity to implement his acquisition and personnel plans. His successor, Rear Adm Ernest King, had similar stature, eventually rising to five-star rank as chief of naval operations in World War II.

By picking leaders of this standing, the Navy proved its commitment to naval aviation. Leadership of such caliber and longevity gave officers the confidence to bet their careers on naval aviation. This leadership also signaled to the entire Navy to get on board—a crucial step to overcome bureaucratic resistance to transformation of this scale.

Dick: I seem to recall that the Navy replicated this model when it integrated nuclear propulsion. Adm Hyman G. Rickover, the head of Naval Reactors for over three decades (1949–82), personally vetted every officer applying for nuclear-engineering duty. Under Rickover, Naval Reactors executed comprehensive responsibility for the development, design, test, and operation of the Navy's nuclear-propulsion program. As with aviation, the Navy combined all elements of a revolutionary technology into one department and entrusted one individual with authority and longevity. This combination attracted and nurtured top talent while overcoming institutional resistance to new technologies.

Jeff: Recall also that the Air Force took a similar approach with Strategic Air Command (SAC). Within about a decade, SAC had deployed revolutionary weapons (such as jet bombers and tankers, plus intercontinental ballistic missiles), developed an organization dedicated to nuclear warfare, and contributed to the Single Integrated Operational Plan and deterrence theory.

This transformation trinity of technology, organization, and doctrine came about under Gen Curtis LeMay and Gen Thomas Power. LeMay commanded SAC for nine years (1948–57) and then oversaw its continued development as vice-chief of staff and chief of staff of the Air Force for another eight years. Power served as LeMay's deputy at SAC for six years (1948–54) and then commanded SAC himself for seven years (1957–64). Both generals had immense credibility as combat leaders during World War II, shared the same institutional vision, and used their longevity in command to transform SAC—and the entire Air Force.[6]

In these three cases, service leaders understood that revolutionary technologies require transformation across the entire institution—and that this transformation requires focused leadership. The lesson for the Air Force's UASs is obvious.

Dick: We're in violent agreement. As an emerging and potentially revolutionary capability, UASs are on a par with the early stages of the development of manned aircraft, jets, missiles, and nuclear power. Their rapid progress will depend upon similar direction and protection. As a first step, UASs will need long-term, credible leadership to implement multiple, interrelated changes across the force. These alterations will range from personnel promotions and assignments, to acquisition and budgets, to organization and doctrine. Identifying, implementing, and following through on these broad changes is an immense task. Historically, the institution stands the best chance of carrying it out by unifying development, placing the best officer in charge, and leaving that person in power for over a decade. The fact that such longevity runs contrary to current Air Force policy reflects the need for transformational approaches.

Hong: We need to remember that UASs will progress outside the military sphere. The civil sector finds them particularly useful for "dull and dirty" missions such as monitoring climate change, tracking the pace and direction of typhoons, and keeping an eye on pipelines and nuclear facilities. This is why major UAS customers include police departments, which use these aircraft for a range of law-enforcement monitoring activities as well as search-and-rescue missions. Farmers also want to use them for agricultural spraying and pest control.

Tony: The importance of a persistent UAS network cannot be overstated. It can redress a critical asymmetric weakness by promising to recover for the United States and its allies the irreplaceable advantage of time. It can enable them to sustain protracted, low intensity conflicts with acceptable political, economic, and casualty risks, or it can provide real-time response to fleeting circumstances. Persistent UASs can deny opportunities for short-term surprise and match the long-term commitment enjoyed by insurgents and other unconventional war fighters. More than that, a network of persistent UASs will enable political leaders and commanders to determine the time scale of appropriate action in anticipation, preemption, or response: a swift, real-time link between information and action in seconds, or a measured reaction over days, months, or even years.

There is also a need for caution amidst the vision and enthusiasm. Military history records the ebb and flow of technology: the swing of the offensive-defensive pendulum when a weapon or system stimulates a counter. The technology of the UAS will be no exception. The lead enjoyed by the United States is likely to reduce as the burgeoning economies of nations such as India and China enhance the indigenous skills and advanced technology of other countries. A military advantage as great as that conferred by UASs is unlikely to remain unchallenged by any state determined to preserve its own freedom of action, especially if its own airspace is invaded or threatened.

Enthusiasts have always been quick to identify airpower's potential. Although UASs do encourage us towards new horizons, our vision must include the questions "Then what?" and "What if?" We must ensure that the vision not only lies within our reach but also remains within our grasp, despite all efforts of opponents to counter it.

This conversation offers a good start—but only a start. Years will pass before the world's airmen build new concepts of operation, new organizations, and new career paths to realize the full potential of UASs.

I am also troubled by the one-sidedness of this conversation. Our adversaries will have their say. It is too bad that we can't include them in our discussion. They may open our eyes to possible impediments we are overlooking. They may also expose new vulnerabilities that UASs could exploit.

All this said, I enjoyed this dialogue. The three of you have recast my conceptions of future unmanned aircraft. For that you have my profound appreciation. ❑

Notes

1. See Alvin Toffler, *The Third Wave* (New York: Morrow, 1980).

2. John A. Tirpak, "Donley and Schwartz Step Up; F-22 Gets Some Love; Why Not Do Both?" *Air Force Magazine* 91, no. 9 (September 2008): 16, http://www.airforce-magazine.com/MagazineArchive/Documents/2008/September%202008/0908watch.pdf.

3. Andrew Marshall, Office of Net Assessment, conversation with the coauthor, 26 March 2004.

4. *Digital Planet 2008: Executive Summary* (Vienna, VA: World Information Technology and Service Alliance, May 2008), 1, http://www.witsa.org/KL08/DigitalPlanet2008ExecSummary_cover.pdf.

5. According to the Heisenberg uncertainty principle, it is impossible to observe an electron without changing it. The mechanics of observation inevitably affect the target of observation.

6. Another example: Gen Bernard Schriever, the "architect of the Air Force's ballistic missile and military space program," led this effort for a dozen years (1954–66). "General Bernard Adolph Schriever," *Air Force Link*, http://www.af.mil/bios/bio.asp?bioID=7069.

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