



U.S. Air Force (Chad Kellum)

Military Officer Attitudes Toward UAV Adoption Exploring Institutional Impediments to Innovation

By JAMES R. FITZSIMONDS and THOMAS G. MAHNKEN

The prospective introduction of large numbers of unmanned aerial vehicles (UAVs) arguably represents the most significant ongoing development in U.S. military aviation in decades.¹ The inventory of large UAVs across all Services is projected to increase from 250 in late 2005 to over 1,400 by 2015. Moreover, more than 1,000 mini-UAVs and an undetermined number of even smaller micro-UAVs are projected to enter service during the same period.² Until recently, it could be argued that immature technology and relatively poor operational performance made UAVs inferior to manned aircraft, even for the

so-called dull, dirty, and dangerous missions.³ However, ongoing developments in computer control and long-range data links show great near-term promise for many types of UAVs to match, or even exceed, the effectiveness of manned aircraft in a number of roles. If so, the growing arsenals of UAVs will have the potential to take increasing numbers of aviators out of the cockpit.

In his well-known case studies of naval innovation, historian Elting Morison characterized a military service as a self-contained society in which members tend to “find the definition of their whole being.”⁴ It is generally accepted that the military profession pos-

sesses a distinct set of traditions and values that defines this society and distinguishes it from the civilian world. As Morison and others have pointed out, transitions from one type of military approach or system to very different operational concepts or technologies have a major impact on the individuals within these societies. Innovations require new types of skills and different professional knowledge, which in turn render the old skills and knowledge less important. Innovative systems generally demand different tactical employment schemes and operational concepts, which in turn affect command authority, hierarchical relationships, and institutional control of both people and resources. Increasing numbers of officers pursuing the new area of professional specialization actively seek different career

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paths for promotion and command, putting them in competition with “traditionalists.” This was certainly true for the introduction of the steamship, aircraft, tank, aircraft carrier, and other major innovations over the past century and a half—all of which generated internal conflicts.

It is likely that such organizational “disorder,” to use Morison’s term, could accompany the large-scale introduction of unmanned aircraft as well. Indeed, a key conclusion of Stephen Rosen’s case studies of military innovation is that because cultural change within the military is so difficult, any major peacetime innovation requires a full generation to complete—enough time for a new cadre of junior officers practicing the new techniques to rise to positions of leadership.⁵

It is the mass of officer practitioners—those below flag level—who must actually adopt and supervise the operation of new systems. They will be the combat users of the new systems, and some will become the future senior leaders of their Services. The common wisdom is that military aviators identify themselves so strongly with manned aviation that they are unlikely to embrace this technological trend. Indeed, some believe that officer pilots today, just like cavalry officers

on the eve of ground force mechanization, could actually impede an objective evaluation of the UAV and introduce unwarranted delays into its operational employment. Despite the potential importance of the broad officer corps to major innovation, there has been exceedingly little empirical information regarding attitudes and actions of these individuals in promoting or impeding major change.

In early 2006, to shed some light on the issue of cultural or social impediments to military-technical innovation, we surveyed nearly 400 officers with aviation specialties who were attending intermediate and senior professional military education institutions.⁶ These schools provided not only a readily accessible survey population but also a body of officers identified by their own Services as having the best prospects for advancement and leadership within the Armed Forces. These are the officers who are most likely to have control over the future acquisition and operational employment of new technologies, such as unmanned systems.

This survey was intended to probe personal issues associated with the career and culture of aviation—such as career choice, professional risk, personal danger, and various aspects of the flying ethos. The goal was to enrich our collective knowledge of what motivates individual officers in

order to determine their receptivity to major institutional change within their own professional specialties during the course of their careers. There was no attempt to evaluate the wisdom of the transition from manned aircraft to UAVs (although an underlying assumption was that these systems appear to have increasing utility). Rather, the intent was to discern how the current practitioners and future leaders of the U.S. military assess the impact of that transition on both themselves and their chosen profession. The immediate intent was to provide useful insights to those seeking to promote the introduction of UAVs and other innovative technologies. Although the survey might accurately reflect current thinking within the officer corps with respect to UAVs, the extent to which these attitudes might manifest themselves in active opposition to change—either through the creation of impediments to the adoption of new systems or simply through neglect to pursue them—might be known with certainty only from a future, retrospective analysis of how these systems fared within the various Services and Service branches. In that respect, this data will ideally serve to inform analysts of innovation some 10 or 20 years in the future.

Our survey showed aviators had attitudes that diverged markedly from popular stereotypes. Contrary to the common wisdom, we found that most aviation officers had little or no expectation of detrimental career impact from the increasing use of unmanned systems. Most aviators appeared to be motivated primarily by professional advancement rather than flying, supporting the notion that a secure career path for promotion and command would be an inducement to attract officers into emerging fields such as unmanned system control. Also contrary to the conventional wisdom, senior officer responses reflected more positive views of both the expectation of the introduction of unmanned systems and the overall impact of unmanned systems on military operations and the military

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Navy RQ-8A vertical takeoff and landing UAV is demonstrated

Hunter Joint Tactical UAV is used
in training exercise



U.S. Air Force (Reynaldo Ramon)

Services than did junior officers. If there was an identifiable “seam of rejection” of autonomous operations, it was in the area of preprogrammed computer “decisionmaking” in determining how and where to employ lethal force.

Expectation of Change

One of the most fundamental questions has to do with aviators’ expectations of future change. Do they expect manned aircraft to be as useful in future years as they are today, or do they believe that UAVs will be increasingly useful? Past survey results have been mixed. In an earlier survey in 2000, for example, we found that 58 percent of all officers canvassed held that manned aircraft would be as important in 2020 as they were at the time. Conversely, 46 percent responded that within the next 20 years, uninhabited combat aerial vehicles would become the predominant means of conducting strike warfare.⁷

Our 2006 survey revealed that most officers believed that although UAVs will play an increasing role, they are unlikely to displace manned aircraft completely in any but limited specialties. Not surprisingly, two-thirds of all officers surveyed believed that during their military careers, UAVs would be operationally fielded in such a way that they would perform at least some of the functions that their air-

craft currently perform. Senior officers (the term applied to officers O-5 and above in this survey) were in slightly more agreement than junior officers (O-4 and below), with 69 percent of senior and 66 percent of junior officers in agreement. However, only 24 percent of officers who believed that UAVs would perform at least some of the functions that their aircraft performed held that UAVs would outnumber manned aircraft in their specialties. As might be expected, given the increasing prevalence of UAVs for surveillance missions, aviators from intelligence, surveillance, and reconnaissance aircraft (E-3, RC-135, EP-3, and U-2) were more inclined to believe that UAVs would outnumber manned aircraft in their specialties.

Importance of Officer Support

As both Eliot Cohen and Adam Grissom have noted, the existing literature on innovation focuses on the top-down direction of senior civilians and military officers; the phenomenon of bottom-up innovation by mid-grade officers has received less study.⁸ Although there is anecdotal evidence from historical case studies that officer-practitioners can be important to the introduction of new innovations, the question of whether broad officer support is critical to success is far from clear. What is clear from

our survey is that most officers believed major innovation was unlikely to succeed without the active support of mid-grade officers in the field.⁹ Two-thirds of all respondents felt that mid-grade officers are critical to the success of major innovations. It should also be noted that nearly one in four did not believe that mid-grade officer support was critical to innovation. Whereas only 50 percent of Army officers believed that mid-grade officer support was important, 66 percent of Navy, 66 percent of Marine Corps, and 69 percent of Air Force officers believed it was.

Flying as a Career Choice

Officer support for the widespread introduction of UAVs is presumably related to the value that the officer attaches to flying. To the extent that aviators value flying, they may resist the introduction of UAVs. As a result, we attempted to explore the personal importance of flying relative to other career choices. Somewhat surprisingly, only 35 percent of aviators responded that they would not have joined the military had they not been able to fly. This suggests that most current aviators were attracted to military service by things other than flying. More predictably, given the centrality of manned flight to the identity of the Air Force, 41 percent of Air Force junior officers responded that they would not have

joined the military if they had not been able to fly. By contrast, only 30 percent of Navy, 19 percent of Marine Corps, and 13 percent of Army aviators gave the same response.

We similarly found that very large percentages of both junior and senior officers would likely complete a full military career even if they could no longer fly. As might be expected, senior officers, who are much closer to retirement and beyond their prime flying days, expressed a stronger likelihood of staying in the military in a nonflying role. Only 10 percent of senior officers responded that they would leave the military before mandatory retirement if they could no longer fly an aircraft. More surprising is the fact that only 19 percent of junior officers (including zero percent for the Army) indicated that they would leave the military if they could no longer fly.

Thirty percent of all officers, and 34 percent of junior officers, indicated that they would choose to transition to flying UAVs rather than leave the military. As might be

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expected, more than 8 in 10 senior officers indicated that they would fly UAVs rather than leave the military.

One of the frequently used arguments for UAVs is that they will free aviators from performing missions that are “dirty, dull, or dangerous.” As a result, we sought to determine how willing aviators would be to hand over “dull” or tedious missions to UAVs.¹⁰ We found that declining tolerance for dull flying missions was somewhat predictably pegged to seniority—with 60 percent of senior officers but only 43 percent of junior officers responding that they would prefer to have a UAV fly a mission that they deemed tedious. This suggests a diminishing allure of flight as pilots accumulate more hours in the air—and likely a greater receptivity to handing those missions over to UAVs.

We also sought to determine the importance of flying relative to command and promotion. Senior officers, whose primary flying days are behind them, opted



Soldiers assemble Raven UAV for short-range reconnaissance

1st Combat Camera Squadron (Russell Cooley)

for command or promotion over flying: 85 percent of senior officers chose command over flying, and 80 percent chose promotion over flying. But more than half of all junior officers in the Army, Navy, and Marine Corps—and nearly half in the Air Force—also opted for command and promotion over flying. This result is quite revealing and indicates that most officers are motivated by incentives that can be accommodated even with the transition to unmanned vehicles. It also supports Rosen’s conclusion that a secure career path—that is, an institutionalized opportunity for promotion and command—is a key incentive for drawing junior officers into new operational specialties. This might be especially important if the new technologies or systems do not offer a significant personal thrill or other allure like flying.

Professional Risk from UAVs

The widespread introduction of UAVs poses several potential professional risks for aviators. A reduction in the number of pilots could lead to diminished opportunities for promotion and command among currently serving officers as well as a loss in organizational influence by aviators—including the power to select the Service’s future leaders. We nonetheless found that more than 70 percent of all respondents did not expect the increasing introduction of UAVs in their specialties

to reduce their personal prospects for promotion. Senior officers (presumably with flying-related promotion criteria behind them) saw less impact than junior officers. It is also noteworthy that Air Force junior officers had the highest expectation of reduction in promotion opportunity from UAVs compared with other junior officer aviators, but still, only 18 percent reflected much concern.

Similarly large majorities did not expect their personal prospects for command to

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decline with the increasing introduction of UAVs in their specialties. Again, senior officers predicted less impact than junior officers (presumably because most command opportunities were behind them). Air Force junior officers had the highest expectation of reduction in command opportunity, but only 21 percent were concerned.

The Flying Ethos

The large-scale introduction of UAVs will change not only the career prospects of

aviators but also the ethos of flying. There are undoubtedly many reasons why individuals join and make a career out of an innately risky profession such as military aviation. Many are likely attracted by the physical and mental challenges of controlling a high performance aircraft in combat—including the social exclusivity of being a highly trained aircraft commander. Many aviators likely identify with the organizational “ethos,” or set of peculiar cultural values, inherent in military aviation squadrons. It is possible that unmanned systems might introduce unacceptable changes to some of the more esoteric aspects of the ethos that personnel find most appealing. The increasing use of unmanned systems will likely alter traditional features of combat—including some aspects of combat leadership. Greater use of autonomous systems for weapons employment could alter the traditional sense of authority and responsibility for assessing risk and applying lethal force—with all of the implications arising from the possibility of fratricide and collateral civilian casualties. UAVs will likely also reduce the experience of personal risk or danger, with diminished opportunities for battlefield valor. Recruiting and retention could be affected by those who fear, as did an early crew member of the USS *Monitor*, that “there isn’t enough danger to give us glory.”¹¹ For Air Force pilots, there



Officer and Airman jointly operate Predator RQ-1 at Tallil Air Base, Iraq

U.S. Air Force (Suzanne Jenkins)

is the added issue of maintaining control of their own Service.

Personal Risk. There would have been no military aircraft, tanks, or submarines if large numbers of officers had not been willing to take on the inherent personal risk of actually climbing into and operating those early crude machines of often dubious safety. Our survey sought to determine the willingness of officers to hand over to UAVs missions that they personally deemed dangerous.¹² Specifically, we asked whether officers would rather have a UAV fly a mission that they deemed “high risk” than to fly that mission themselves. Fifty-six percent of officers overall expressed a preference to fly even high-risk missions, suggesting an inherent attraction of risk in manned flight. The issue of willingness to accept risk also showed a marked, and somewhat predictable, difference between junior and senior officers, with 44 percent of senior officers but only 28 percent of junior officers amenable to handing over high-risk missions to unmanned aircraft. There was also a significant difference among the Services—and especially between the ground forces—with 50 percent of the Army aviators willing to cede dangerous missions to UAVs, but only 17 percent of Marines showing a preference to do so. Such a result perhaps reflects the close tie that exists between Marine aviators and ground forces.

Control of UAVs by “Pilots.” It is debatable whether UAVs can be operated successfully in the future without control by rated “pilots” having extensive flight experience in manned aircraft. The issue of “stick” handling might be irrelevant if future UAVs are essentially autonomous—responding to preprogrammed algorithms and simple keyboard inputs—and do not require direct flight control. Interestingly, 40 percent of all respondents believed that UAVs should be controlled only by individuals qualified to pilot an aircraft. Moreover, there were significant Service differences on this matter: 11 percent of Marine officers, 15 percent of Army officers, and 33 percent of Navy officers—but 51 percent of Air Force officers—expressed the belief that only pilots should control UAVs. At least part of the explanation is likely that Air Force UAVs tend to be much larger than those in use by the other Services, with support and control requirements relating more closely to manned aircraft. Current practice in the Air Force, but not in the other Services, is that UAV operators be rated aviators. There might

also be an ingrained cultural proclivity within the Air Force to identify the pilot with the aircraft, or simply widespread belief that trained pilots are likely critical to the success of any type of major aviation program.

Control of UAVs by “Officers.” Enlisted military pilots were not uncommon through World War II, primarily due to a need for rapid expansion of the pilot ranks. Since then, aircraft pilots in the U.S. military have been almost exclusively commissioned or warrant officers. Whether this is primarily a cultural issue (“pilot” and “officer” being seen as synonymous) or a question of command authority and individual responsibility is unknown. In looking to the future, we sought to determine whether officers felt that UAVs should be flown or controlled only by commissioned or warrant officers. What we found was a significant split. Whereas 36 percent of senior officers felt that only officers should control UAVs, 49 percent of junior officers did. The reason for the senior-junior split is not known, but junior officers might fear reduced opportunities for promotion and command if control of UAVs were widely opened to enlisted personnel. The Air Force divergence from the other Services is also noteworthy. Whereas 55 percent of Air Force

UAVs and Individual Valor. The Distinguished Flying Cross (DFC) is awarded to an individual who “distinguishes himself by heroism or extraordinary achievement while participating in an aerial flight.” The award is generally assumed to involve both risk to and achievement by an individual while airborne. We sought to determine whether officers believed that a UAV operator could someday be recognized with the DFC for an extraordinary combat achievement while, presumably, not being airborne and under no personal risk. Very large majorities—and notably, a far higher percentage of seniors than juniors—rejected this notion. There was also little uncertainty on this issue, suggesting the deeply held opinion that at least for some level of personal awards, human risk should always be a distinguishing criterion. Nevertheless, 15 percent of respondents overall, and 22 percent of Air Force respondents in particular, expressed some measure of agreement with the statement. It must be emphasized that responses do not necessarily signify agreement with the idea of awarding a DFC to a UAV operator, but simply the expectation that it will happen. This particular statement elicited a number of written comments—all critical—and reflected something of the

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officers believed that only officers should control UAVs, 49 percent of Navy, 10 percent of Army, and 9 percent of Marine aviators felt the same way. As noted above, current Air Force UAVs are much larger than those in use by the other Services, and they are operated by commissioned officers. But the responses also beg the question of whether most Air Force aviators culturally equate the pilot to an officer, or whether there are issues of command authority and responsibility that drove this response.

UAV Operators as Warfighters. We also sought to determine whether aviators considered UAV operators to be “warfighters.” We found that 74 percent of officers overall agreed with the statement “UAV operators are warfighters.” Perhaps counterintuitively, more seniors (83 percent) than juniors (71 percent) agreed with this statement, suggesting a different notion of “warfighter” between the age groups.

visceral emotion of combat valor. One respondent termed the question itself “incredibly disturbing.” Another suggested the creation of a new type of award to recognize the combat achievements of UAV operators.

Autonomous Control of Lethal Force. A major argument for more autonomy in UAV systems is to reduce the vulnerability of UAV data links to interdiction by enemy action. As one survey respondent commented, “The moment an adversary learns to jam the command/control link of UAVs, we’re in trouble.” Yet 59 percent of all respondents rejected the prospect of autonomous application of lethal force, agreeing that enemy targets should be engaged with lethal force only by systems that allow direct human intervention or control. This is an interesting result. Although U.S. doctrine has been migrating away from indirect area fires—including harassment and interdiction artillery fire and aerial bombardment—launching

lethal ordnance at a distant geographic position where enemy forces are expected to be located has become common practice. Presumably, most officers accept the use of global positioning system-guided ordnance such as cruise missiles and the Joint Direct Attack Munition, suggesting that there is some level of autonomous control they do not find unsettling. One can speculate that this relates to autonomous target identification by

most officers see a continuing need for individual humans to monitor, evaluate, and approve all lethal force “decisions” by autonomous platforms

the system on the scene as opposed to human input of target data. Interestingly, the concept of lethal force without direct human intervention or control was rejected by a higher percentage of junior than senior officers. The Service breakout is also noteworthy, with only slightly more than one-third of Army respondents agreeing with this statement.

Confidence in Assessments

We sought to understand officers’ knowledge of their Service branch plans for the introduction of UAVs. Senior officers expressed far more confidence in their knowledge than junior officers, with 65 percent of senior officers and 59 percent of junior officers assessing that they were adequately informed to make substantive decisions with respect to the introduction or use of UAVs in their specialties. This might be expected since senior officers generally have held positions that are closer to such program details and decisions. This also might explain why seniors appear to be more open to UAVs, and the impact of UAVs, in many of the earlier statements.

We also asked officers to assess the adequacy of their superiors’ knowledge to make substantive decisions with respect to the introduction of UAVs. Fifty-five percent of all officers expressed confidence in their superiors. The Service breakout is interesting, with majorities of Army, Air Force, and Marine Corps aviators, but fewer than half of Navy respondents, expressing such confidence in their superiors. In contrast to the other Services, most Army respondents expressed more

confidence in their superiors’ judgment than their own.

Finally, very large percentages of officers believed that the pace at which UAVs were being introduced was “about right” (see table). Interestingly, a much higher percentage of seniors than juniors believed that the pace was “not fast enough”—and a higher percentage of junior officers felt that the pace was “too fast.” One interpretation could be that junior officers are not as “forward thinking” as senior officers, or not as knowledgeable of UAVs. Another interpretation could be that junior officers have more legitimate concerns about the pace of UAV introduction at the tactical level given the current state of technology.

Summary

One survey respondent reflected the popular view of aviators toward UAVs when he commented, “God willing, there will never be a time when UAVs take over the job of a qualified and competent fighter pilot.” Yet in his exhaustive study of the history of UAVs in the U.S. military through the late 1990s, Thomas Ehrhard found “no parochial, pilot resistance standing in the way of UAV development in the Air Force, only a general enthusiasm for UAVs that in retrospect was not supported by the technology of the time.”¹³

Our survey corroborates Ehrhard’s conclusion, revealing no widespread or deep-seated opposition to UAVs beyond technological uncertainty. We found that, in general, aviators did not believe that they would see the large-scale displacement of manned aircraft by UAVs in their own specialties during the remainder of their careers. Thus, most saw no detrimental career impact from the ongoing introduction of UAVs. Most aviators

also expressed a willingness to pursue their military careers even if displaced by UAVs. For the majority of officers, military service itself, rather than flying, appeared to be the primary career motivator. Most aviators indicated that they would select promotion or command if forced to choose either of those over flying. This tends to support the theory that the establishment of a secure career path will motivate a large percentage of officers to enter new career fields with different types of systems and skills.

We also found that in most areas, senior officers showed more receptivity to UAVs and changes wrought by UAVs than did junior officers—even in those cases where future career impact did not appear to be a factor. In particular, senior officers were more open to what might be considered cultural change to the “institution” of flying, including UAV control by nonpilots, UAV control by enlisted personnel, and consideration of UAV operators as warfighters. More senior officers than junior officers also believed that UAVs were not being introduced fast enough. These responses tend to refute the stereotypical notion of conservative senior officers squelching the innovative ferment within the junior officer ranks.

In general, Air Force aviators showed more traditionalism than did officers in the other Services with respect to UAVs, with substantial percentages opposing UAV control by individuals other than officer pilots. However, it is not evident from the survey data that this opposition is rooted in culture rather than issues arising from command authority and responsibility. Moreover, this would reflect a more informed view if Ehrhard is right in his observation that a pilot-centric “aviation

The Pace at Which UAVs Are Being Introduced into My Specialty Is . . .			
	Not Fast Enough (percent)	About Right (percent)	Too Fast (percent)
All Officers	18	71	11
0–4 and Below	15	72	13
0–5 and Above	26	68	6
Army	20	70	10
Navy	22	73	5
Air Force	17	68	15
Marine Corps	15	83	2

discipline” might be critical to successful UAV operations.

If there is a seam of rejection, it would appear to lie in the degree of autonomy afforded to UAVs. With the notable exception of the Army, large majorities of aviators hold to the view that enemy targets should not be engaged with lethal force by systems without direct human intervention or control, thus seeming to reject fully autonomous systems that search for, identify, track, target, and destroy enemy targets.¹⁴ The implication is that officers will likely insist on direct communications with unmanned systems for the application of lethal force at least against mobile or relocatable targets—with the resulting provision for secure communications pathways between the system and the human controller regardless of distance or enemy actions. Most officers see a continuing need for individual humans to monitor, evaluate, and approve all lethal force “decisions” by perhaps large numbers of autonomous platforms. Future developments will determine whether the pace of high-intensity combat operations, and possible enemy use of autonomous systems without a human in the loop, will force U.S. military officers to accommodate more autonomy in the application of lethal force.

The lack of evidence of outright rejection of UAVs may stem, as Ehrhard suggests, from the creeping automation that has occurred in manned flight over the past decade or so—both in precision-guided munitions and flight controls.¹⁵ The average Navy strike-fighter pilot now accepts the fact that he must have his hand off the stick controls of his F/A-18 in order for it to launch from a carrier deck. Thus, the distinction between the manned aircraft and UAV is gradually diminishing even for the pilot in the cockpit. Another factor in UAV acceptance might be that the most significant large UAV program, Predator, has been flown and managed by rated pilots in the Air Force who cycle between manned and unmanned platforms. Aviators with higher career aspirations (as most seem to have), therefore, might be just as likely to seek excellence in UAV operations as manned aircraft operations. Manned aviation also has significant “ownership”—and likely pride in that ownership—of the growing Predator fleet. As the Air Force transitions to a dedicated UAV training and operational career path, it will be interesting to see whether segregating the officer corps into

manned and unmanned operators will kindle career and cultural competition that impedes UAV development and integration.

Whether or not the preferences expressed in this survey will accurately reflect officer actions in response to the growing numbers of increasingly autonomous systems remains to be seen. Perhaps institutionally based opposition will emerge when major organizational and professional changes wrought by growing numbers of unmanned systems actually begin to ripple through the Services. A retrospective analysis of the transition from manned to unmanned flight will be needed over the coming decades to determine whether institutional factors actually played any role in impeding technological innovation. **JFQ**

NOTES

¹ Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: The Joint Staff, April 12, 2001), defines UAV as “A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Ballistic or semi-ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles.” The term *unmanned aircraft system* (UAS) is now used by the Defense Department in place of UAV to emphasize that the aircraft vehicle is only one component of the system, and due to the fact that the Federal Aviation Administration uses the term *UAV* to designate specific types of UAS falling under regulatory control.

² Office of the Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005–2030* (Washington, DC: Office of the Secretary of Defense, August 4, 2005), 26–37.

³ See Thomas Paul Ehrhard, “Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapon System Innovation” (Ph.D. diss., The Johns Hopkins University, June 2000).

⁴ Elting E. Morison, *Men, Machines, and Modern Times* (Cambridge: The Massachusetts Institute of Technology Press, 1966), 34.

⁵ Stephen P. Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca: Cornell University Press, 1991).

⁶ The professional military education institutions surveyed comprised the U.S. Naval War College, U.S. Army War College, Air War College, Air Command and Staff College, National War College, Industrial College of the Armed Forces, Marine Corps War College, Army Command

and General Staff College, Air Command and Staff College, Marine Corps Command and Staff College, School of Advanced Air Power Studies, School of Advanced Warfighting, Air Force Squadron Officers School, and Expeditionary Warfare School. Respondents had the following officer specialty codes: Army (15X/Aviation), Navy (131X/Pilot and 132X/Naval Flight Officer), Air Force (11XX/Pilot and 12XX/Navigator), and Marine Corps (75/Pilot/Naval Flight Officer).

⁷ Thomas G. Mahnken and James R. FitzSimonds, *The Limits of Transformation: Officer Attitudes toward the Revolution in Military Affairs*, Newport Paper 17 (Newport, RI: Naval War College Press, 2003), 30–33. See also Thomas G. Mahnken and James R. FitzSimonds, “Revolutionary Ambivalence: Understanding Officer Attitudes toward Transformation,” *International Security* 28, no. 2 (Fall 2003).

⁸ See Eliot A. Cohen, “Change and Transformation in Military Affairs,” *Journal of Strategic Studies* 27, no. 3 (September 2004), 395–407; and Adam Grissom, “The Future of Military Innovation Studies,” *Journal of Strategic Studies* 29, no. 5 (October 2006).

⁹ The term *mid-grade* was not further defined in the survey.

¹⁰ The term *tedious* was not further defined and is likely to be highly individual. For the purposes of this statement, it was deemed sufficient for the respondent to consider his or her own definition of a tedious mission. Officers were asked to provide percentages of overall flight hours that they deemed tedious. Most felt that the majority of their flight hours were not tedious. As might be expected, senior officers tended to assess a higher percentage of their own flight hours as tedious than did junior officers.

¹¹ This was the question posed by William Frederick Keeler when assigned as the first paymaster of the USS *Monitor*. Subsequent action confirmed that there was still abundant danger—and opportunity for glory—even in an armored ship. See David A. Mindell, *War, Technology, and Experience aboard the USS Monitor* (Baltimore: The Johns Hopkins University Press, 2000), 2.

¹² The term *high risk* was not further defined and is likely to be highly individual. For the purposes of this statement, it was deemed sufficient for the respondent to consider his or her own definition of a high-risk mission.

¹³ Ehrhard, 493.

¹⁴ The Low Cost Autonomous Attack System (LOCAAS) developed and tested by Lockheed-Martin was just such a system. It was rejected by the Air Force due, among other things, to the lack of a man-in-the-loop to control the attack. The basic LOCAAS technology has since been resurrected in other strike systems that provide for human intervention in the attack process.

¹⁵ Ehrhard, 625.