Back From the Future

The Impact of Change on Airpower in the Decades Ahead

Mark Clodfelter

Forecasting the future is an inherently uncertain endeavor that carries great implications for military force structures and doctrines. As military leaders try to determine if their services are postured to thwart anticipated threats and flexible enough to adapt to unknown challenges, they confront the notion of *change*—the conviction that war is an evolving phenomenon subject to periodic transformations. *The Joint Operating Environment 2008: Challenges and Implications for the Future Joint Force*, published by US Joint Forces Command in November 2008, is one of many recent attempts to forecast the changing conditions that the American military will likely face in the next quarter century; other militaries will doubtless produce their own projections.[1]

Air forces are especially prone to emphasizing how change affects war. Because of their heavy dependence on technology to fight in an unfriendly medium and the transitory nature of operations in the air, they place perhaps a greater premium on the relationship between war and change than the other military services.[2] Yet change in war stems from more than simply technological advance. As Carl von Clausewitz observed almost two centuries ago, the composition of forces, the objectives they pursue, and how they choose to pursue those goals can often affect the conduct of war as much as the technology used by military forces. Clausewitz further maintained that military transformations occur against the backdrop of constants that comprise war's enduring nature. Although the Prussian military philosopher never saw an aircraft, his fundamental notions regarding change and war apply directly to Airmen and their political masters attempting to

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visualize the future. For airpower to be an effective military instrument in the decades ahead, the political and military leaders who employ it must be able to distinguish between the aspects of war that change and those that endure over time.[3]

The Fundamental Nature of War

Clausewitz rightly noted that war is not a stagnant endeavor. The *manner in which it is conducted* is not a constant, and technological change is one reason for that disparity. The invention of the airplane, jet engine, laser-guided bomb, GPS satellite, et cetera, et cetera, all affect *how* war is waged. Equally significant, the *character* of war is also not a constant and is defined by *who* fights and *why* they do so. Since the time of Clausewitz and the rise of "citizen soldier" armies triggered by the French Revolution, the composition of military forces has varied greatly, as have the political goals pursued by those who directed armies, navies, and air forces. The combination of changes in *both* the character and conduct of war has spurred different strategic approaches—for example, strategies of annihilation vs. strategies of attrition, strategies emphasizing conventional methods vs. irregular techniques, and sequential vs. parallel strategies, just to name a few—and such strategic choices have profound ramifications for the employment of airpower. Thus, *change* consists, in part, of evolving variations in war's character *and* conduct. Those developments, and the strategic approaches that flow from them, will help determine whether airpower succeeds.

Defining success, though, may prove difficult for leaders who turn to airpower in the years ahead. Clausewitz offered guidance for that definition. He wrote that war's "grammar, indeed, may be its own, but not its logic."[4] The grammar of war is relatively straightforward and consists of the tools of war and their manner of employment to be effective—for instance, the combination of astronautics, aeronautics, physics, and computer science that enables a GPS-guided 2000-lb joint direct attack munition (JDAM) to hit its target when dropped from an F-15E five miles away. Yet unless the "logic" of the war is also correct, the smooth application of its grammar is no guarantee of success. Is the target hit by the JDAM actually the correct one for an air strike? What is the connection between the target bombed and war aims pursued? How does destroying a particular target move the nation applying airpower a step closer to "victory"—and what, precisely, is the definition of that elusive term? For the application of airpower, or any

military instrument, to be successful, it must help to achieve the desired political objectives of those who use it.

Understanding how change in war will impact airpower's effectiveness requires first understanding those aspects of war that endure over time. Accordingly, one must appreciate war's *constants* to identify its transitions, and war has more than a few attributes that are *un*changing. Clausewitz contended that those constant elements comprise war's *nature*—components that would always be present, regardless of how, when, or where war was fought. Three key, interrelated elements form Clausewitz's nature of war. First, war will always have emotion—passion, enmity, and hatred—that spurs it towards violence. Next, war will always contain friction—the unexpected, chance, danger, and exertion—and the creativity to counter those disruptive forces. And finally, reason will always drive war, though the logic that produces the decision to fight and defines the objectives may not be readily apparent to all observers—and may, indeed, prove faulty. Together, those three components form Clausewitz's Trinity of War, and the manner in which they relate to one another is likely to be different for every conflict. Yet a relationship among the three is *always* present. Clausewitz further observed that emotion will mainly—but not exclusively—affect the populace; friction and creativity will mainly—but not exclusively—affect the armed forces and their commanders; and reason will mainly—but not exclusively—affect the governmental body directing the war effort.[5] Airmen who fail to appreciate that those relationships exist—and *how* they bond together for a specific enemy or ally, as well as for his or her own nation—stand on very shaky ground, especially if they must apply kinetic force to help achieve political goals.

Thus, before knowing how change is likely to affect the employment of airpower, commanders must understand and define the *constants*. They must decipher the logic that is likely to guide the enemy leader's use of force, determine how passion may inflame an enemy populace, and envisage the creative measures that enemy commanders are likely to adopt when faced by the unexpected. Commanders must likewise comprehend the rationale behind the political objectives pursued by their own nation, and the constraints that help to refine those objectives, plus they must appreciate the support that the war effort will likely receive from their own populace—as well as on the stage of world public opinion. The commander must further have a thorough understanding of the capabilities available for use—not just the airpower capabilities, but also those of land and sea forces—and

a full appreciation that the enemy is going to do everything possible to negate those advantages; the last thing that an opponent is going to do is "fight fair."

In short, twenty-first-century leaders must be well versed in what may be termed Clausewitz's fundamental law: "The first, the supreme, the most far-reaching act of judgment that the statesman and commander have to make is to establish . . . the kind of war on which they are embarking; neither mistaking it for, nor trying to turn it into, something that is alien to its nature."[6] He added: "No one starts a war—or rather, no one in his senses ought to do so—without first being clear in his mind what he intends to achieve by that war and how he intends to conduct it."[7] The key for the air commander, as well as for the political leader who gives the commander orders, is never to forget that war—and hence airpower—are political instruments designed to achieve specific national goals, and the manner in which the airpower is used, and its true test of effectiveness, depends on how well it suits the war aims sought. This fundamental truth hearkens back to Giulio Douhet, Hugh Trenchard, and Billy Mitchell, yet today we continually hear the mantra of "effects based" airpower—that designed specifically to achieve broad, systematic results on an enemy's war-making ability or behavior.[8] Pure and simple—if airpower fails to support the political goal sought, it will not be effective—a true statement for the twenty-first century and the centuries that follow.

Airpower in the Context of Change in War

With that brief—but necessary—foundation of how understanding the unchanging *nature* of war is fundamental to the sound use of airpower in the years ahead, let us return to the facets of war that are almost certain to change in the future—war's *conduct* and *character*—and how those changes are likely to affect Airmen. As mentioned, technological advance is a key factor in the ever-changing conduct of war, and continued high-tech developments will have significant consequences for the world's air forces. First and foremost, increasingly sophisticated technologies will come with a steep price tag, and those costs will limit the ability of many nations to generate a substantial air force, especially one capable of providing more than self-defense.

The conduct of war on a global scale using high-technology platforms has become increasingly expensive. The US Air Force—the world's only

air force with a truly global capability—has pursued a 2009 budget of almost $144 billion, roughly 28 percent of the $515 billion sought by the entire Department of Defense.[9] The request is $8.6 billion more than the Air Force received for 2008, and more than $2 billion of the increase will go toward expenses for fuel and utilities.[10] Just a $10 rise for a barrel of oil costs the Air Force almost $600 million a year.[11] To curb spending, the service has developed a fuel blend that includes synthetic kerosene derived from natural gas, and the trend towards synthetic fuels will influence many air forces in the years ahead. The fluctuating price of oil has helped limit the US Air Force to request only 93 new aircraft for 2009.[12] Of that total, just 28 are fighters—20 F-22s and 8 F-35s. The "fly away" costs for these aircraft—which include money spent only on production, not research and development[13]—come to between 140 and 160 million dollars for each F-22 and $50 million for each F-35—a combined total of roughly $3.5 billion.[14]

Such staggering costs for the latest and greatest in high-tech sophistication guarantee not only that a decreasing number of fifth-generation fighters will replace their fourth-generation counterparts, but also that many nations will consider alternatives to creating their own fifth-generation fighter. Most countries simply cannot afford to fund such a project alone, and the international backing that has highlighted the development of the F-35 is a trend that will continue in the decades ahead.[15] Russia and India announced in December 2007 that they would jointly develop and produce a fifth-generation, multirole fighter that could appear on the market between 2015 and 2020.[16] For nations looking to upgrade their kinetic airpower capabilities, multirole capability is the key; gone are the days when aircraft designs would focus specifically on air superiority, strategic bombing, or close air support.[17] The F-22 can carry eight GBU-39 small-diameter bombs, while F-35 variants can carry as many as six AIM-120C radar-guided air-to-air missiles; the costs to build high-speed, thrust-vectoring, stealthy, super-cruise aircraft are simply too great not to incorporate the maximum on them in terms of combat capabilities. The multirole requirements create potential problems, though, for the pilots who must master the sophisticated technologies associated with each of the aircrafts' various missions. How much training is enough to achieve proficiency in each task—and how much training will pilots receive, given the shifting fuel costs of the next two decades?[18]

All enemies do not wage the same type of war, and how an enemy chooses to fight significantly affects how Airmen can use their technology to confront that foe. Continued evolutions in the character and conduct of war have generated an amorphous type of conflict that Gen Rupert Smith calls "war amongst people," which "reflects the hard fact that there is no secluded battlefield on which armies engage, nor are there necessarily armies, definitely not on all sides." Smith contends that in such wars "civilians are the targets, objectives to be won, as much as an opposing force."[19]

Frank Hoffman's notion of "hybrid warfare" parallels Smith's view of future combat. In hybrid warfare, distinctive categories of conflict, such as conventional and irregular, blur together. This blending includes "the convergence of the physical and the psychological, the kinetic and the nonkinetic, and combatants and noncombatants."[20] Colin Gray, Max Boot, Robert Gates, Michèle Flournoy, and Shawn Brimley echo Hoffman's concern that hybrid wars will present special challenges in the years ahead for Western militaries geared toward confronting separate types of conflict.[21] Such wars can be waged by state or nonstate actors, and they will present dilemmas for Airmen who must decipher the myriad approaches that an enemy may take to negate an airpower advantage.

For potential opponents with limited resources, the enormous costs associated with developing and maintaining an air force may cause some of them to concede control of the sky. Yet others may choose to focus on relatively inexpensive—compared to the cost of fourth- or fifth-generation fighters—ground-based defenses, as well as such "old-fashioned" methods of thwarting airpower as dispersal, camouflage, and concrete. In addition, as conflicts in Iraq, Afghanistan, Lebanon, and Gaza have illustrated, an enemy can turn to asymmetric techniques to thwart airpower, or it can respond with its own version of an air offensive. In addition to firing more than 4,000 rockets, Hezbollah fought back against the Israelis in 2006 by launching three Mirsad-1 unmanned aerial vehicles (UAV) that carried 50-kilogram bombs, plus it fired C-802 Noor cruise missiles against an Israeli ship.[22] Less expensive technology also has a great deal of attraction for those who might wage hybrid wars, and such "proven" methods of attack as improvised explosive devices (IED) and suicide bombers will likely continue.

Airpower's best option for helping to cope with such strategies will be to improve intelligence, surveillance, and reconnaissance (ISR) techniques—not kinetics. The problem with using bombs against hybrid enemies is friction:

the lack of certainty, even with incredibly accurate precision capabilities, that the bombs will hit the desired target—and only the desired target—or that the target struck is indeed the correct one. As the Israelis learned in Lebanon in 2006 and have confirmed in Gaza this year, a savvy opponent is not going to launch attacks from remote, isolated areas. Collateral damage provides a great boost when it comes to thwarting airpower, and that truism is not going to disappear in the next two decades. The 24-hour news coverage provided by media giants such as CNN, the BBC, and Al Jazeera is tailor-made for displaying civilian deaths to the world at large. Hezbollah units fighting the Israelis in 2006 assured that camera crews tagged along with them, so that reporters with laptops and cameras could send broadband transmissions of alleged bombing mistakes to appear on television broadcasts within minutes. Hezbollah further relied on sympathetic bloggers, self-generated e-mail, and its own satellite TV station to convey its views around the globe.[23] The Israelis have tried to limit Western reporting from Gaza in 2009, but Al Jazeera has furthered the Hamas cause with a dedicated channel of war coverage on YouTube and a Twitter feed that references Internet war updates.[24] Future combatants who shift back and forth between conventional and irregular techniques will continue to rely on such "information warfare" methods to stymie air attacks.[25]

Complicated struggles like those in the Middle East show just how important an understanding of passion, reason, and friction are for Airmen. Such hybrid conflicts are a near certainty in the future because they afford weaker opponents key advantages when they attempt to compete against larger, better-equipped adversaries. Airmen will find themselves seeking the utmost in precision capability, whether bombs are used for close air support or for targeting "high value" enemy leaders, in what will become an increasingly complex combat environment. The US Air Force is working on a second variant of its 250-lb small-diameter bomb that could engage moving targets in all weather conditions and is also designing a low-cost miniature cruise missile that either F-22s or F-35s could carry internally.[26] Yet such munitions, especially those guided by GPS, are vulnerable to jamming from a plethora of inexpensive devices that an enemy could readily acquire. The Pentagon is developing antijamming systems, but the "measure-countermeasure" race offers no guarantees regarding which side will have the technological edge once combat occurs.

Moreover, as America's eight-year struggle in Southeast Asia exemplified, a vast technological superiority in the precise application of lethal

force is no guarantee of victory. Airmen must identify the character and conduct of the war that they encounter and choose their technological tools accordingly. They must further understand the elements comprising the enemy's "Trinity of War" and how those constants may negate the weapons systems they have at their disposal. In the amorphous conflicts they will most likely face in the future, firepower, no matter how precise, is unlikely to yield the success necessary to secure the war aims sought—and in some cases it may well produce the antithesis of the desired effects. Vietnam stands as a stark reminder—and warning—that sophisticated weaponry is not an approved solution against a highly motivated, resourceful opponent who chooses to fight in unconventional ways.[27]

Airpower's nonlethal applications, such as surveillance and reconnaissance, provide greater help in defeating enemies waging predominantly guerrilla war than a reliance on kinetics. Northrop Grumman has begun tests on airborne radar that can track individuals as they leave vehicles to plant roadside bombs. Known as "VADER", for Vehicle and Dismount Exploitation Radar, it will fit on the US Army's Sky Warrior UAV and ultimately go to the Beechcraft King aircraft flown by the Iraqi air force.[28] Besides its use against IEDs, the radar also offers value as a border surveillance device.

Such developments increase the likelihood that UAVs will form the key component of surveillance and reconnaissance activities against opponents relying on guerrilla techniques in the decades ahead. Of the 93 new aircraft requested by the US Air Force for 2009, 52 are UAVs,[29] and the emphasis on unmanned surveillance aircraft is not likely to abate. As Sir Brian Burridge observed, UAVs are perfectly suited to airpower's "3D Tasks"—those that are "dull, dirty, and dangerous."[30] The Air Force's MQ-1 Predator amassed 150,000 flight hours in Iraq and Afghanistan during a 14-month stretch from June 2007 to August 2008, compared to 250,000 hours that the Predator had accumulated in mid-2007 after 12 *years* of operation! As of September 2008, the Predator force of 165 aircraft averaged a combined total of 14,000 flying hours a month, a number that is certain to increase along with the demand.[31]

UAVs like Predator do not come without concerns, however. The rapid surge in their numbers has caused the US Air Force to discard the restriction that only rated pilots can fly them,[32] which could diminish the situational awareness of some operators.[33] The rise in UAV numbers has also created command and control problems in an increasingly congested aerial environment. In the US command structure, the joint force air component commander (JFACC),

typically an Air Force officer, would prefer to control all such vehicles, but the Army and Marines have their own UAVs, many of which are quite small and designed for platoon-sized operations. They are unlikely to relinquish their control any time soon.[34] In addition, the Air Force has taken to arming the Predator and its larger counterpart, the MQ-9 Reaper, with Hellfire missiles and has suffered the same problems of collateral damage as it has from manned aircraft firing precision-guided weapons. For Predator to be a true asset in combating enemies who prefer to fight "amongst the people," the information that it provides needs to be paired with a command and control structure appropriate to the kind of war being fought. The only time that it should act as a bombing platform is when the target that it has identified is clear, unequivocal, and isolated.

In future wars against opponents who fight from civilian landscapes, nonlethal airpower in the form of ISR will likely prove a great asset, and so too will airlift. Air transport can move troops to key locations; the pairing of special operations forces with helicopters or C-130s has emerged as a hallmark of the war in Afghanistan. Moreover, in such wars for "hearts and minds," airlift can often provide humanitarian assistance for the ill or impoverished, the material necessary to build key elements of infrastructure, and a means to establish essential links to government centers that ground transport cannot fulfill. To help satisfy those needs, Lockheed Martin is developing an advanced composition cargo aircraft, which will have a fuselage crafted from composite materials with many fewer parts than today's aircraft.[35] This technology will also support the design of the advanced joint air combat system, or AJACS, a projected replacement for the venerable C-130 in the 2020 time frame. The US Air Force currently possesses 435 C-130s (the oldest of which date to 1962), 176 C-17s, and 111 C-5s (with more than half dating from the 1970s),[36] which, along with its tanker force, give the United States a truly global capacity to move military personnel and equipment at a moment's notice. If the United States is to maintain that capability, it must begin to think about—and organize itself for—joint and interagency operations beyond just kinetics.

Despite the emergence of hybrid wars, conflicts with a conventional focus are unlikely to disappear completely in the future. Against enemies that stress conventional war-fighting techniques, airlift and ISR will remain crucial capabilities for a nation relying on airpower, though the emphasis would likely shift to air components that apply lethal force directly. Indeed, as Colin Gray has observed, in "regular, conventional war" scenarios,

airpower will be the dominant force, with ground power playing a supporting role.[37] Robert Pape agrees, and has noted that air forces will provide a precise "hammer" to strike the "anvil" that friendly ground forces create by halting enemy movement.[38] Such conflicts would seemingly suit fifth-generation fighters like the F-22, which has thus far sat out the fighting in Iraq and Afghanistan. Hinting at China, former USAF chief of staff, Gen T. Michael Moseley, warned in December 2007 that the United States might one day confront "rising peer competitors with voracious appetites for resources and influence."[39]

Yet even with the continued modernization of weaponry by both the Chinese and Russians, to include plans for their own fifth-generation fighters, the prospect of direct conflict in the years ahead between the United States and allies against either the Chinese or Russians is remote. Besides the obvious threat of nuclear escalation, other factors limit the chances for conventional combat. The Chinese own almost 15 percent of America's $10 trillion national debt and have continued to purchase US treasury bonds during the current market downturn.[40] The ties that forged the economic powerhouse dubbed "Chimerica" by Niall Ferguson are unlikely to loosen in the years ahead; the combination of China's demographic imbalance, environmental degradation, and political corruption decreases prospects that its manufacturing sector will shift its focus from exporting consumer goods to America.[41] In short, the Chinese would probably not wish to sabotage their own financial health by conventional combat with the United States. The Russians, despite their bluster, would probably not wish to engage in a war that could pit them against all of NATO and threaten their oil and natural gas sales to many of the alliance nations, particularly those in Western Europe.[42]

These uncertainties complicate strategic force design, but just because overt conflict with China or Russia may seem unlikely does not mean that the United States or its allies will avoid systems developed by those countries in future wars. The Chinese have developed the sophisticated Chengdu J-10 fighter, which will be a formidable opponent for many aircraft with its PL-12 radar-guided, air-to-air missiles. The Russians have made a strong pitch to sell their "generation 4.5" MiG-35 worldwide, and appear to have the inside track in the six-nation competition for 126 multirole fighters to outfit the Indian air force.[43] The Russians further plan to have their fifth-generation Sukhoi T-50 operational by 2013 and to sell it on the open market.[44] Some nations may prefer the Chengdu and

its estimated price tag of $25–40 million, which is relatively inexpensive compared to the existing competition, including an upgraded F-16.[45] In the realm of ground-based air defenses, Russia's newest surface-to-air missiles have established reputations as effective weapons, and many countries, including China and Iran, possess them.[46]

While an air-to-air showdown between either China or Russia and the United States is unlikely, such a confrontation could well occur in space or cyberspace. In 2000, a Chinese military strategist referred to America's dependence on space assets and information technology as "soft ribs and strategic weaknesses,"[47] and the Chinese have responded with extensive efforts in those arenas. They revealed an ability to "paint" American satellites with ground-based lasers in August 2006.[48] In early 2007, the Chinese demonstrated an effective antisatellite capability by firing a ground-based medium-range ballistic missile that hit one of their aging weather satellites.[49] That capability is a direct threat to American satellites monitoring daily activities such as financial transactions, power grids, and telephone communications, as well as those providing GPS data to smart munitions. A significant loss of satellites would have a profound impact on America's ability to provide air support to Taiwan should war with China occur there. Still, for the Chinese to risk war with the United States over the sovereignty of Taiwan—much less over downed satellites—runs counter to logic that the Chinese have displayed in a nonviolent march towards regional hegemony.[50] A more plausible way for them to check America's military might is to attack through cyberspace—a means that is difficult to pinpoint with absolute certainty—as they demonstrated by hacking Pentagon computers in June 2007.[51] The Russians may have followed suit in November 2008 in a cyber attack that affected computer networks within US Central Command as well as the Pentagon.[52] More attacks are likely.

China, Russia, and the United States are unlikely to fight each other directly any time soon, but "state vs. state" warfare still remains a distinct possibility for much of the globe, with airpower playing a substantial role. Should war occur without one of those three powers, their equipment would probably still dominate any battle for control of the sky. Russia recently offered to provide Lebanon with 10 MiG-29s.[53] Yet in the future, many nations that relied on Russian aircraft in the past will have opted for American designs. Romania, Poland, and Morocco now fly F-16s, and—no surprise—Iraq and Afghanistan have also purchased American aircraft. The UK, Italy, Australia, Canada, Denmark, the Netherlands, Norway, and

Turkey will all possess the F-35,[54] and the odds are high that Israel, Singapore, Japan, Greece, Spain, Romania, and Bolivia will as well.[55] To help keep production lines open for the F-16 and C-17, America has boosted foreign military sales,[56] and a similar goal could cause Lockheed Martin to seek approval to sell the F-22 to additional allied nations, especially in the current period of economic uncertainty. The United States has increased its status as the world's major arms supplier, and, in the airpower realm, that trend will continue as states flock to buy precision-guided munitions and missile-defense systems as well as aircraft. Such high-tech splurges have grave ramifications, though, because foreign leaders may feel inclined to use the new hardware to guarantee a "bang for their buck" rather than have it sit dormant. In a world of ever-emerging threats, matched by old animosities that refuse to disappear, the prospect that technological fanaticism may fuel the impetus for war is a scary possibility.[57]

Having high-tech airpower seemingly available to settle old scores or beat down new foes is dangerous because it affects the "reason" aspect of Clausewitz's trinity. The head of state who accepts the frequently touted progressive mantra that airpower makes wars cheaper, quicker, and more efficient than land or sea forces may turn to bombing to achieve political goals deemed unobtainable with armies or navies.[58] Other leaders may view the acquisition of airpower as a goal unto itself, much like a fleet-in-being that would provide regional clout and deter potential opponents. In either example, airpower has the potential to alter the character of war by expanding the political goals desired and reducing the manpower needed to achieve them. The combination of airpower and nuclear weapons, seen today in North Korea with similar prospects for development in Iran, would further transform the character of war if conflict occurred with one of those two outlier states.

Opposing such an enemy would be anything but simple, and airpower would likely provide the dominant element of force. Much like China or Russia, North Korea would present any nation considering the use of lethal airpower against it with difficult choices because of the potential for nuclear retaliation. Iran could present a similar dilemma, depending on whether it had perfected a nuclear weapon before an attack against it occurred.[59] In either case, ISR technology would play a vital role, especially in terms of the information received from satellites that can now distinguish objects as small as 16 inches from 420 miles above the earth's surface.[60] Yet equally, if not more, important would be the intelligence

gleaned regarding the *intentions* of those leaders who possess the bomb. Simply knowing the locations of nuclear facilities and assuring their destruction would not suffice to achieve *lasting* results. Enduring success would require deciphering the specific war aims sought by enemy leaders and containing the religious or ideological fervor that could affect their logic as they direct their forces.

Moreover, such a conflict would demand not only pristine intelligence that guaranteed the location and destruction of all nuclear facilities *before* catastrophic harm occurred, but also the epitome of precision bombing to assure that catastrophic harm did not result from the very effort designed to prevent it. As Bernard Brodie observed a half-century ago, a people irradiated by collateral damage would probably not be too grateful for their salvation from nuclear attack.[61] Any application of kinetic airpower would receive intense scrutiny, and the nations that use it must be ready for the repercussions. World public opinion will offer various assessments, with certain ethnic, religious, or ideological groups perhaps using the attacks as impetus for their own future activities. World leaders will also make their own judgments regarding the impact of the air strikes. Those who seek nuclear weapons will pay special attention to airpower's perceived ability to forestall that development and may well act on their evaluations.

Although a rogue state's pursuit of a nuclear arsenal may trigger an air war in the years ahead, combat applications of airpower are more likely to stem from "traditional" efforts to change or preserve national borders. Russia's incursion into Georgia provides a recent example of a "conventional" display of airpower that will likely continue in the next two decades; NATO air strikes in Bosnia in 1995 and Serbia in 1999 provide more distant episodes. For two nations that both possess substantial air forces and a contentious border area, such as India and Pakistan, the prospect that a conflict could occur is ever present and especially ominous because both nations have nuclear arsenals. An air war there will remain a possibility, and should it occur, one has to hope that the reason aspect of the Clausewitzian trinity dominates emotion.

Airpower's ability to prevent nuclear devastation stands as its greatest challenge in the decades ahead. In that respect, changes in the character and conduct of war stemming from the potential proliferation of nuclear weapons to terrorists emerge as the thorniest test for future air commanders. As with a potential war against a nuclear North Korea or Iran, ISR assets must generate key data, but will the information provided suffice, or will

it overload the system—and, if the necessary information *is* gleaned, will it receive the correct interpretation? How will the leaders of the threatened nations *act* on the information received? Unlike most nation-state leaders, true terrorists are likely to be much more difficult to deter—if indeed deterrence is an option. Locating them and their nuclear device—or devices—and determining the means of delivery are essential to thwarting an attack. Airpower's odds of success are highest if the delivery method is via ballistic missile, because the most means would exist to stop it: an air strike wrecking the launch site or the missile's destruction by a surface-based defense system or airborne laser, all are possibilities. Thus, terrorists would likely seek an alternative delivery method. Should they resort to a cruise missile, container ship, or suitcase, ISR's importance becomes paramount, although human intelligence would probably be just as significant, if not more so. If those techniques yield the location of terrorist weapons, the leaders of the targeted nations would likely face a grave dilemma in determining how to respond. An air strike would be one possibility, but that option might carry with it the prospect of significant collateral damage, to include radiation. Yet, should intelligence pinpoint the location of the terrorists and their nuclear weapons, an air strike may be deemed the best option available.

Today's terrorists have demonstrated a solid appreciation for the principles of airpower; the 9/11 attacks were vintage examples of Douhet's prescription for striking the capability and will of an enemy state. Commercial airliners, cruise missiles, Scuds, and rockets provide potential terrorists with a "poor man's air force" capable of wreaking substantial havoc. Stopping such air strikes will not be easy, even for nations possessing sophisticated air defenses. In these asymmetric clashes of airpower, the side that possesses the dominant technology may not have the decisive edge.

What then can we say with certainty regarding the impact of change on airpower in the next two decades? In terms of specifics, we can say little with assurance. Yet, in general terms, we can offer a few observations. First, airpower and change will continue to have a symbiotic relationship—changes in the character and conduct of war will affect airpower effectiveness, and airpower developments will induce change in the character and conduct of war. Second, technological change is likely to yield an airpower advantage for only a brief period of time. Human beings are innovative creatures with remarkable abilities to counter threats, and the ever-expanding resources of a globalized world will multiply their prospects for doing so in the future.[62] Finally, the developments that facilitate control of the sky

should benefit the nation that uses them to that end, but command of the air does not guarantee success.

Almost 90 years ago, Douhet argued that such control equated to victory. He envisioned only one type of war, however—a total struggle for unlimited aims. War's character and conduct have continued to evolve, and the changes stemming from that evolution will profoundly affect airpower's utility in the decades ahead. "Victory smiles upon those who anticipate the changes in the character of war," Douhet wrote in 1921, "not upon those who wait to adapt themselves after the changes have occurred."[63] His guidance on that score offers sound advice for twenty-first-century air commanders—provided that they also have a full appreciation for the nature of the war on which they are about to embark. SSQ

Notes

1. US Joint Forces Command, *The Joint Operating Environment 2008: Challenges and Implications of the Future Joint Force*, 25 November 2008, http://www.jfcom.mil/newslink/storyarchive/2008/JOE2008.pdf.
2. Carl Builder observed that the US Air Force "could be said to worship at the altar of technology," an assessment that likely reflects the focus of many officers in air forces worldwide. See *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: Johns Hopkins University Press, 1989), 19. In a brief, thoughtful essay, Lt Col Paul Berg amplifies the emphasis that American Airmen place on technological advance. See "Doctrine and Technology," *Air and Space Power Journal* 22 (Spring 2008): 20.
3. Despite being written almost a decade ago, Dennis M. Drew's "The Essence of Aerospace Power: What Leaders Need to Know," *Aerospace Power Journal* 15 (Summer 2001): 23–31, remains an excellent guide for those grappling with how best to apply airpower to achieve political effects.
4. Carl von Clausewitz, *On War*, ed. and trans. by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 605.
5. Ibid., 89.
6. Ibid., 88–89.
7. Ibid., 579.
8. Jack Sine, "Defining the 'Precision Weapon' in Effects-Based Terms," *Air and Space Power Journal* 20 (Spring 2006): 81–88, provides a representative example of the emphasis given "effects based" airpower. For an engaging debate on the utility of the term *effects-based*, see P. Mason Carpenter and William F. Andrews, "Effects-based Operations: Combat Proven," *Joint Force Quarterly* 52 (Winter 2009): 78–81; and Paul K. Van Riper, "EBO: There Was No Baby in the Bathwater," *Joint Force Quarterly* 52 (Winter 2009): 82–85.
9. Michael C. Sirak, "By the Numbers," *Air Force Magazine Online Daily Report eNewsletter*, 5 February 2008, http://www.airforce-magazine.com/Features/modernization/Pages/box020408budget.aspx.
10. Ibid.
11. Marc V. Schanz, "The Fuel War," *Air Force Magazine*, June 2007, 47.
12. Sirak, "By the Numbers."

13. Dan Ritschel, Michael A. Greiner, Daniel E. Reynolds, and Michael J. Seibel, "Flyaway Costs Versus Individual Components of Aircraft: An Analysis," *Air Force Journal of Logistics* 27 (Winter 2003): 32.

14. Amy Butler and David A. Fulghum, "Fate of F-22, C-17 Lines Uncertain in Fiscal Year 2009," *Aviation Week and Space Technology*, 10 February 2008, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/aw021108p2.xml&headline=Fate%20of%20F-22,%20C-17%20Lines%20Uncertain%20in%20Fiscal%202009; Pierre Sprey, James Stevenson, and Winslow Wheeler, "The F-22: expensive, irrelevant, and counterproductive," *Fort Worth Star-Telegram*, 27 January 2008; Amy Butler, Graham Warwick, and Andy Nativi, "Cost Question," *Aviation Week and Space Technology*, 14 July 2008, 86; and John A. Tirpak, "Bets Down on Lightning II," *Air Force Magazine*, July 2008, 27. Unit costs of the F-35 are especially difficult to determine at this juncture. The contract for the second lot of low-rate initial production aircraft was announced on 22 May 2008 as $2.2 billion for 12 aircraft, and Maj Gen Charles R. Davis, USAF, the F-35 program manager, noted in April 2008 that "every day we get more actuals [real costs] on what it takes to build an airplane. We also get better every time we build an airplane. It gives us a better understanding of what jets and later lots will cost." See Tirpak, "Bets Down on Lightning II," 28. The *Washington Post* reported that Congress had approved $6.3 billion for 14 F-35s in FY-2009, which would include funding for a small number of each of the models desired by the various services—the short take-off/vertical landing model F-35B desired by the Marine Corps; the larger, aircraft-carrier-capable F-35C desired by the Navy; and the F-35A "standard" model sought by the Air Force. Those figures, however, likely include research and development costs in addition to the costs to build individual aircraft. See Dana Hedgpeth, "Balancing Defense and the Budget," *Washington Post*, 13 October 2008. Ultimately, the Air Force plans to buy 1,763 F-35As, which would produce a "ballpark" flyaway cost of $60–70 million per aircraft, while costs for the B and C models would run $80–85 million apiece. See Tirpak, 25, 29.

15. The trend truly began in the 1970s. First, Britain and France combined to produce the Jaguar, and then Britain, Germany, and Italy produced the Tornado. Next, Britain, France, and Germany began work on the Eurofighter, which first flew in 2000 after France had dropped out of the project and Spain and Italy had joined in. See Tony Mason, *Air Power: A Centennial Appraisal* (London: Brassey's, 1994), 246.

16. "Russia Starts Building Fifth-Generation Fighter Aircraft," *Moscow News*, 13 December 2007, http://www.mnweekly.ru/news/20071213/55296954.html; and "US, Russia, China in Dogfight Over Jet Sales," *Moscow News*, 27 March 2008, http://www.mnweekly.ru/business/20080327/55319264.html.

17. Air Vice-Marshal Tony Mason made this point in 1994, and it remains equally valid for the decades ahead. See Mason, *Air Power*, 267–68.

18. Through 2013, the US Air Force Flying Hour Program Budget is scheduled for a 10-percent reduction each year, and fuel costs are a major reason for the decline. See Schanz, "The Fuel War," 47.

19. Rupert Smith, *The Utility of Force: The Art of War in the Modern World* (New York: Alfred A. Knopf, 2005, 2007), 5–6.

20. Frank G. Hoffman, "Hybrid Warfare and Challenges," *Joint Force Quarterly* 52 (Winter 2009): 34.

21. Colin S. Gray, *Another Bloody Century: Future Warfare* (London: Weidenfeld & Nicolson, 2006), 168–69, 199–200; Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Gotham Books, 2006), 472; Robert M. Gates, "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88 (January–February 2009): 33–35; and Michèle Flournoy and Shawn Brimley, "The Defense Inheritance: Challenges and Choices for the Next Pentagon Team," *Washington Quarterly* 31 (Autumn 2008): 63–66.

22. Andrew Exum, *Hizballah at War: A Military Assessment*, Policy Focus #63 (Washington, DC: Washington Institute for Near East Policy, December 2006), 5–7.

23. Marvin Kalb and Carol Saivetz, "The Israeli-Hezbollah War of 2006: The Media as a Weapon in Asymmetrical Conflict," 18 February 2007, http://www.brookings.edu/~/media/Files/events/2007/0217islamic%20world/2007islamforum_israel%20hezb%20war.pdf. See also Sanu Kainikara and Russell Parkin, *Pathways to Victory: Observations from the 2006 Israel-Hezbollah Conflict* (Tuggeranong, Australia: Air Power Development Centre, 2007), 77, 82–83; and Stephen Biddle and Jeffrey A. Friedman, *The 2006 Lebanon Campaign and the Future of Warfare: Implications for Army and Defense Policy* (Carlisle, PA: Strategic Studies Institute, 2008), 50–56.

24. Noam Cohen, "Few in U.S. See Jazeera's Coverage of Gaza War," *New York Times*, 12 January 2009.

25. Military analyst Bill Arkin notes: "The 'failure' of airpower in the 2006 Israel-Hezbollah war was not that it promised too much or that it did not deliver. It was instead a grand strategic failure in the application of force against terrorism. The war demonstrates and justifies a clear transition needed from conventional to wholly new modes of warfare required for counterterrorism in the future." See William M. Arkin, "Divine Victory for Whom? Airpower in the 2006 Israel-Hezbollah War," *Strategic Studies Quarterly* 1 (Winter 2007): 131. Arkin's article is adapted from his book, *Divining Victory: Airpower in the 2006 Israel-Hezbollah War* (Maxwell AFB, AL: Air University Press, 2007).

26. Douglas Barrie, Amy Butler, and David A. Fulghum, "Sound and Fury," *Aviation Week and Space Technology*, 14 July 2008, 116–20.

27. See Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (Lincoln: University of Nebraska Press, 2006).

28. Graham Warwick, "No Hiding Place," *Aviation Week and Space Technology*, 28 July 2008, 62.

29. Sirak, "By the Numbers."

30. Sir Brian Burridge, "Trenchard Memorial Lecture," 17 September 2004, in *Royal Air Force Air Power Review* 8 (Spring 2005): 7.

31. "Grinding It Out," *Air Force Magazine Online Daily Report eNewsletter*, 20 August 2008, http://www.airforce-magazine.com/DRArchive/Pages/2008/August%202008/August%2020%202008/GrindingItOut.aspx.

32. "Rated to Fly," *Air Force Magazine Online Daily Report eNewsletter*, 17 September 2008, http://www.airforce-magazine.com/DRArchive/Pages/2008/September%202008/September%2017%202008/ReadytoFly.aspx.

33. US Air Force studies show that many UAV pilots suffer from "sensory exhaustion," a problem of chronic fatigue that results from the lack of sensory cues received while remotely controlling aircraft thousands of miles away. See Aaron Retica, "Drone-pilot Burnout," *New York Times*, 14 December 2008.

34. The debate between the US Army and the US Air Force over command and control of UAVs has at times been contentious. See "Sooner, Not Later," *Air Force Magazine Online Daily Report eNewsletter*, 22 June 2007, http://www.airforce-magazine.com/DRArchive/Pages/2007/June%202007/June%2022%202007/1090sooner.aspx. While some progress has been made in specifying "who owns what," problems still remain. See "UAV Deconfliction Moving Ahead," *Air Force Magazine Online Daily Report eNewsletter*, 17 December 2008, http://www.airforce-magazine.com/DRArchive/Pages/2008/December%202008/December%2017%202008/UAVDeconflictionMovingAhead.aspx.

35. Amy Butler and Graham Warwick, "Cargo Composites," *Aviation Week and Space Technology*, 14 July 2008, 122.

36. US Air Force Fact Sheet, "C-130 Hercules," September 2008; US Air Force Fact Sheet, "C-17 Globemaster III," September 2008; US Air Force Fact Sheet, "C-5 Galaxy," April 2008.

37. One might add: "at least in the short term." See Colin S. Gray, "Understanding Airpower: Bonfire of the Fallacies," *Strategic Studies Quarterly* 2 (Winter 2008): 57–61.

38. Robert A. Pape, "The True Worth of Air Power," *Foreign Affairs* 83 (March–April 2004): 116–20.

39. Gen T. Michael Moseley, "The Nation's Guardians: America's 21st Century Air Force," CSAF White Paper, 29 December 2007, 3.

40. James Fallows, "The $1.4 Trillion Question," *Atlantic*, January–February 2008, http://www.theatlantic.com/doc/200801/fallows-chinese-dollars; *Report to Congress of the U.S.-China Economic and Security Review Commission*, November 2008 (Washington, DC: US Government Printing Office [GPO], 2008), 2–5; Mark Landler, "Chinese Savings Helped Inflate American Bubble," *New York Times*, 26 December 2008; and Keith Bradsher, "China Losing Taste for Debt From U.S.," *New York Times*, 8 January 2009. At the end of November 2008, the Chinese owned $585 billion of the US Treasury's $4.4 trillion debt, more than any other foreign nation; that total had climbed to $652 billion by the end of December.

41. Niall Ferguson, "What 'Chimerica' Hath Wrought," *American Interest* (January–February 2009), http://www.the-american-interest.com/ai2/article.cfm?Id=533&MId=23. See also "Geopolitical Diary: Why China Needs U.S. Debt," *Stratfor*, 13 February 2009, http://www.stratfor.com/geopolitical_diary/20090212_geopolitical_diary_why_china_needs_u_s_debt.

42. "Gas Wars," *Economist*, 10 January 2009, 12; and "Pipe Down," *Economist*, 10 January 2009, 44–45.

43. "MiG-35: Top Candidate for Air Force MRCA Deal," *india-defence.com*, 23 January 2007, http://www.india-defence.com/reports/2831.

44. "Russian Air Force may receive fifth generation fighter in 2013," *Russian News and Information Agency Novosti*, 7 July 2008, http://en.rian.ru/russia/20080707/113422740.html.

45. David Lague, "China builds a superpower fighter," *International Herald Tribune*, 8 February 2007.

46. These surface-to-air missiles include Russia's "S-300" series weapons, which comprise the SA-10, SA-12, and SA-20 missiles and their complementing radars, plus the follow-on "S-400" system weaponry. The SA-20 enables the defender to engage six targets simultaneously at a range of 248 miles, six times the range of the SA-6 that it replaced. Iran has purchased many of the S-300 series missiles, as have the Chinese. See John A. Tirpak, "The Double-Digit SAMs," *Air Force Magazine*, June 2001, 48–49.

47. Wang Huacheng, "The US Military's 'Soft Ribs' and Strategic Weaknesses," *Liaowang* 27, reprinted in *Xinhua Hong Kong Service*, 5 July 2000 in FBIA–CHI–2000–0705, 25 July 2000, cited in *Report to Congress of the U.S.-China Economic and Security Review Commission*, November 2008 (Washington, DC: GPO, 2008), 156.

48. "Chinese Anti-Satellite [ASAT] Capabilities," *GlobalSecurity.org*, http://www.globalsecurity.org/space/world/china/asat.htm.

49. Carin Zissis, "China's Anti-Satellite Test," Council on Foreign Relations backgrounder, 22 February 2007, http://www.cfr.org/publication/12684/.

50. The Chinese announced in their most recent National Defense White Paper: "The attempts of the separatist forces for 'Taiwan independence' to seek 'de jure Taiwan independence' have been thwarted, and the situation across the Taiwan Straits has taken a significantly positive turn. The two sides have resumed and made progress in consultations on the common political basis of the '1992 Consensus,' and consequently cross-Straits relations have improved." See Information Office of the State Council of the People's Republic of China, *China's National Defense in 2008* (Beijing: January 2009), 5–6.

51. Demetri Sevastopulo, "Chinese Hacked into Pentagon, *Financial Times*, 3 September 2007.

52. Julian E. Barnes, "Cyber-attack on Defense Department computers raises concerns," *Los Angeles Times*, 28 November 2008. The article noted that the attack "may have originated in Russia"; a Russian cyber attack shut down government computers in Estonia in 2007.

53. Robert F. Worth, "Russia, Testing U.S. Sway, Offers Lebanon 10 Warplanes," *New York Times*, 18 December 2008.

54. The Norwegian prime minister announced on 24 November 2008, after an evaluation of the F-35 against the Saab Gripen NG, that the F-35 is the "only candidate" that fulfills Norway's operational requirements. The Norwegians plan to acquire 48 F-35s to replace their F-16s, with the first deliveries planned for 2016. See "Count Us In," *Air Force Magazine Online Daily Report eNewsletter*, 25 November 2008, http://www.airforce-magazine.com/DRArchive/Pages/default.aspx. Similarly, Air Marshal Mark Binskin, chief of the Royal Australian Air Force, announced that his nation must buy 100 F-35s despite the shrinking defense budget, and that the F-35 would replace aging F-111s and F/A-18s. See "Aussies Confirm 100 is the Number," *Air Force Magazine Online Daily Report eNewsletter*, 4 December 2008, http://www.airforce-magazine.com/DRArchive/Pages/default.aspx.

55. Butler, Warwick, and Nativi, "Cost Question," 86. The Pentagon announced in October 2008 that it planned to sell between 25 and 75 F-35s to Israel. See "Pentagon Approves Israeli F-35 Sale," *Air Force Magazine Online Daily Report eNewsletter*, 3 October 2008, http://www.airforce-magazine.com/DRArchive/Pages/2008/October%202008/October%2003%202008/PentagonApprovesIsraeliF-35Sale.aspx.

56. Eric Lipton, "With White House Push, U.S. Arms Sales Jump," *New York Times*, 14 September 2008.

57. For a compelling analysis of how technological fanaticism can affect airpower development, see Michael S. Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven, CT: Yale University Press, 1987).

58. For a study of how America's wartime presidents, from Franklin Roosevelt to George W. Bush, embraced airpower's progressive notions, see Mark Clodfelter, "A Strategy Based on Faith: The Enduring Appeal of Progressive American Airpower," *Joint Force Quarterly* 49 (Spring 2008): 24–31, 150–60.

59. David Kay, the former UN inspector, contends that Iran is already "80 percent of the way to a functioning nuclear weapon." See "The Iranian Fallout," *National Interest* (September–October 2008): 1. The International Atomic Energy Agency reported in late November 2008 that Iran had produced enough nuclear material to make, with added purification, a single atomic bomb. See William J. Broad and David E. Sanger, "Iran Said to Have Nuclear Fuel for One Weapon," *New York Times*, 20 November 2008.

60. "High Resolution Satellite Launched in California," *International Herald Tribune*, 6 September 2008.

61. Bernard Brodie, *Strategy in the Missile Age* (Princeton, NJ: Princeton University Press, 1959), 324–25.

62. US Joint Forces Command, *Joint Operating Environment* 2008, 48, amplifies this point.

63. Giulio Douhet, *The Command of the Air*, trans. by Dino Ferrari (New York: Coward-McCann, Inc., 1942; reprint ed., Washington, DC: Office of Air Force History, 1983), 30.