Weapons: The Growth & Spread of the Precision-Strike Regime

Thomas G. Mahnken

Abstract: For two decades, scholars and practitioners have argued that the world is experiencing a Revolution in Military Affairs brought on by the development and diffusion of precision-strike and related capabilities. The United States took an early lead in exploiting the promise of precision-strike systems, and the use of precision weaponry has given the United States a battlefield edge for twenty years. However, these weapons are now spreading: other countries, and non-state actors, are acquiring them and developing countermeasures against them. As the precision-strike regime matures, the United States will see its edge erode. The ability of the United States to project power will diminish considerably. In addition, U.S. forces, and eventually the United States itself, will be increasingly vulnerable to precision weapons in the hands of our adversaries.

THOMAS G. MAHNKEN is the Jerome E. Levy Chair of Economic Geography and National Security at the U.S. Naval War College and a Visiting Scholar at the Philip Merrill Center for Strategic Studies at Johns Hopkins University. In 2006 to 2009, he served as the Deputy Assistant Secretary of Defense for Policy Planning. His most recent book is *Technology and the American Way of War since 1945* (2008).

For two decades, scholars and practitioners have argued that the world is experiencing a Revolution in Military Affairs (RMA) brought on by the development and diffusion of precision-strike and related capabilities, such as intelligence, surveillance, and reconnaissance; precision navigation and tracking; and robustly improved command and control. The United States took an early lead in exploiting the promise of precision-strike systems, and the use of precision weaponry has given the United States a battlefield edge for some twenty years. However, precision-strike systems are now spreading: other countries, and non-state actors, are acquiring them and developing countermeasures against them. As the precision-strike regime matures, the United States will see its edge erode. The ability of the United States to project power will diminish considerably. In addition, U.S. forces, and eventually the United States itself, will be increasingly vulnerable to precision weapons in the hands of our adversaries.

This essay begins by exploring the concept of an RMA as well as the general structure of military revolutions. Using this model, the essay then describes

the growth of the precision-strike regime to date; speculates on the features of a mature precision-strike regime; and concludes with some implications for the United States.

The evolution of military technology and doctrine has redefined the conduct of war throughout history.[1] Defense policy analyst Andrew F. Krepinevich, for example, has identified ten military revolutions stretching back to the fourteenth century.[2] These include the Napoleonic revolution of the late eighteenth and early nineteenth centuries, which saw the advent of the mass army; the adoption of the railroad, rifle, and telegraph in the mid-nineteenth century, which marked the industrialization of warfare; and the development of nuclear weapons in the twentieth century. Although each revolution was unique in its origin, trajectory, and content, all shared common features. In each case, new combat methods arose that displaced previously dominant forms of warfare by shifting the balance between offense and defense, space and time, and fire and maneuver.[3] The states that first adopted these innovations gained a significant advantage, forcing competitors to match or counter them to have any chance of prevailing on the battlefield. Those who adapted, prospered, while those who did not, declined, often precipitously.

Military revolutions display a common structure: a cycle of innovation, diffusion, and refinement. Their development is driven not just by changes in the character and conduct of war, but also by the perceptions of both participants and observers that change is afoot and drastic action is required. Indeed, the perception of dramatic change and the urgent need to respond to it is a defining feature of a military revolution. For example, although scholars debate whether something called *blitzkrieg* actually existed in German military doctrine, the demonstrated effectiveness of combined-arms armored warfare against France and the Low Countries in May and June 1940 convinced participant and observer alike that the character of warfare had shifted, and compelled them to respond by changing their force structure and doctrine.[4]

The Embryonic Phase. The first phase of a new revolution builds on the achievements of the preceding cycle, while the last phase forms the foundation of the next transformation. During the first, or embryonic, phase, military organizations refine old combat methods and experiment with new ones in an effort to gain or maintain advantage against potential adversaries.[5] Most major military innovations have, in fact, come about because of the perception of an operational or strategic problem that defied a conventional solution.

New weaponry alone is insufficient to transform warfare.[6] Those practices that have changed the character and conduct of warfare have combined weapon systems with innovative operational concepts and the organizations necessary to carry them out.[7] Yet determining how new weapons and concepts will perform without the test of war is exceedingly difficult. In peacetime, military organizations operate, in the words of military historian Sir Michael Howard, in "a fog of peace."[8] They must place bets about the effectiveness of new and unproven ways of war, but combat is the only, and final, arbiter. In addition, past experience serves as a cognitive anchor that limits the ability of military organizations to comprehend the magnitude of change that is under way and constrains the ability of intelligence organizations to understand foreign military developments.[9] As a result, periods of change in the character and conduct of warfare frequently witness a growing gap between perception and reality. The mag-

nitude of this divergence depends on the amount of time that passes between wars and the amount of technological and doctrinal dynamism in the interwar period.

The Immature Phase. The second, or immature, phase of a military revolution begins with the successful use of new military practices in a major war. Success often takes the form of a decisive battle or campaign in which forces that have mastered new combat methods defeat those who remain wedded to traditional approaches. The demonstrated effectiveness of these methods realigns perception and reality, convinces belligerent and observer alike of a change in the character of warfare, and forces both friend and foe to adjust their force structure and doctrine. For example, revolutionary France's adoption of the *levée en masse* not only allowed it to survive, but also permitted Napoleon to win a series of decisive battles against his foes at Ulm, Austerlitz, Jena, and Auerstadt. Prussia's embrace of the railroad, rifle, and telegraph helped it, the least of Europe's great powers, defeat Austria at Königgrätz and France at Sedan and unify the German state. And Germany's use of combined-arms armored warfare delivered a series of quick decisive victories in the opening campaigns of World War II.

One way military organizations adjust to new combat methods is by emulating successful practices. Indeed, the spread of new capabilities offers the central mechanism by which one military regime supplants another. Military organizations may attempt to import foreign practices wholesale; more often, however, they modify them somewhat in the process.[10]

Adversaries may also attempt to develop countermeasures to new combat methods, particularly when the barriers to emulation are prohibitively high. As British Army officer and military historian J.F.C. Fuller put it, "[E]very improvement in armament is eventually met by a counter-improvement which gradually or rapidly whittles down its power."[11] Although technical and operational countermeasures rarely succeed in nullifying the effectiveness of new military practices, they do, over time, erode it somewhat.[12] The competition between measure and countermeasure becomes a defining feature of the ensuing military regime.

The process of emulation is typically neither rapid (let alone automatic) nor complete.[13] First, the process of change in military organizations is wrenching and painful, reducing their effectiveness in the short term even if it promises to increase it in the long term. As a result, military leaders tend to delay difficult change unless and until it is starkly apparent that it is necessary. Second, leaders may disagree in their perception of the threat environment, including debates over which contingencies are most serious and when they might arise. Third, the path to success is rarely obvious. Military organizations may have difficulty perceiving that a military revolution is under way even after new practices have appeared on the battlefield. Because new combat methods often have their roots in the past, contemporary observers may fail to discern what is new and different about them. Fourth, the organizational culture of the military can constrain both how it perceives the environment and how it responds.[14] Organizations may emphasize those events that are in accord with doctrine and discard those that contradict it.

The Mature Phase. The spread of successful practices creates a new style of warfare that supplants the existing paradigm. The inauguration of a new military regime marks the third, or mature, phase of a revolution. The basis for competition in a mature regime is different from that in a developing one. In the latter, advantage accrues to the military that is best able to exploit an emerging innovation; in the

former, advantage accrues to those powers that are able to replicate an innovation on a large scale. Whereas a developing regime often witnesses wars of maneuver and quick, decisive victories, a mature regime is characterized by wars of attrition. For example, Germany used its early lead in developing combined-arms armored warfare to defeat Poland, France, and the Low Countries in the early phases of World War II. However, in an example of successful emulation, Germany was ultimately defeated by a coalition that was able to field far more tanks than the Germans were, and to use them reasonably well.[15]

The structure of military revolutions is easiest to discern in retrospect, with the benefit of hindsight once history has rendered its verdict. It is far more difficult to comprehend contemporary developments, not least because we are immersed in them. Nonetheless, we can cast our gaze backward to the origins of the precision-strike revolution, and we should look ahead to predict, albeit with a sense of modesty, its future course.

The embryonic phase of the precision-strike revolution stretched from World War II to the end of the Cold War. Guided weapons, including the V-1 cruise missile and V-2 ballistic missile, but also the Fritz X air-to-surface weapon, were first used in combat by Germany during World War II. However, the United States took the lead in developing precision weapons in the decades that followed.[16] Indeed, many of the weapon systems associated with the information revolution – precision-guided munitions (PGMs), unmanned air vehicles (UAVs), and sensors – date back to the 1960s and 1970s, and many saw their debut in the Vietnam War. Between 1968 and 1973, for example, the Air Force and Navy expended more than 28,000 laser-guided bombs (LGBs) in Southeast Asia, mainly against bridges and transportation chokepoints.[17]

The seeming ease with which the U.S.-led coalition defeated Iraq during the 1991 Gulf War caused many observers in the United States and elsewhere to conclude that the information revolution was bringing about a new RMA.[18] In their view, the lopsided battles in the deserts of Kuwait and southern Iraq and the seemingly effortless domination of the Iraqi air force signaled that warfare had indeed changed. The contrast between prewar expectations of a bloody fight and the wartime reality of Iraqi collapse struck many as indicating a transformation in warfare.

The 1991 Gulf War thus marked the transition between the embryonic and immature phases of the precision-strike revolution. The combination of the stealthy F-117 *Nighthawk* aircraft and PGMs gave U.S. forces extremely high effectiveness. A typical non-stealth strike formation in the Gulf War required thirty-eight aircraft, including electronic warfare and defense suppression aircraft, to allow eight planes to deliver bombs on three targets. By contrast, only twenty F-117s armed with 2,000-lb LGBs were able simultaneously to attack thirty-seven targets in the face of more challenging defenses. As a result, although F-117s flew only 2 percent of the total attack sorties in the war, they struck nearly 40 percent of strategic targets, such as leadership and command and control facilities. In addition, the war witnessed the innovative use of PGMs to strike not only fixed strategic targets and hardened aircraft shelters, but also Iraqi tanks in revetments. On one night alone, 46 F-111F attack aircraft dropped 184 LGBs, which destroyed 132 Iraqi armored vehicles.[19] Despite the fact that PGMs accounted for only 8 percent of the bombs dropped over Kuwait and Iraq, televised scenes of U.S. aircraft bombing targets with precision, broadcast world-

wide, became the most evocative images of the war.

In the years that followed, the war became a central reference point in debates over the hypothesis that an RMA was under way.[20] Some of the more breathless RMA advocates argued that the information revolution marked a complete break with the past. One 1993 report predicted: "The Military Technical Revolution has the potential fundamentally to reshape the nature of warfare. Basic principles of strategy since the time of Machiavelli . . . may lose their relevance in the face of emerging technologies and doctrines."[21] The authors of the Air Force's official study of the Gulf War were closer to the mark when they concluded, "The ingredients for a transformation of war may well have become visible in the Gulf War, but if a revolution is to occur someone will have to make it."[22]

The United States embraced precision weaponry in the decade that followed the Gulf War. Throughout the 1990s, the combination of stealth and precision-guided munitions gave U.S. air forces the ability to strike adversaries from the air with near impunity. In addition, airpower seemed uniquely suited to the types of conflicts in which the United States was involved: wars for limited aims, fought with partial means, for marginal interests. Airpower coupled with PGMs appeared to offer the ability to coerce Iraq, intervene in the Balkans, and retaliate against terrorist groups while avoiding the difficult decisions associated with a sustained commitment of ground forces.

The congressionally mandated 1997 Quadrennial Defense Review acknowledged the existence of an RMA and committed the department to transforming the U.S. armed forces. As Secretary of Defense William Cohen put it: "The information revolution is creating a Revolution in Military Affairs that will fundamentally change the way U.S. forces fight. We must exploit these and other technologies to dominate in battle."[23] That same year, the congressionally mandated National Defense Panel (NDP) argued even more strongly in favor of the need to transform U.S. forces. The panel's report suggested that an RMA was under way and urged the Defense Department leadership to "undertake a broad transformation of its military and national security structures, operational concepts and equipment, and . . . key business processes." The report stated:

> We are on the cusp of a military revolution stimulated by rapid advances in information and information-related technologies. This implies a growing potential to detect, identify, and track far greater numbers of targets over a larger area for a longer time than ever before, and to provide this information much more quickly and effectively than heretofore possible. Those who can exploit these advantages – and thereby dissipate the fog of war – stand to gain significant advantages. . . . [The Defense Department] should accord the highest priority to executing a transformation of the U.S. military, starting now.[24]

Much of the discussion of the RMA in the 1990s was predicated on opportunity: the United States should pursue new ways of war because they would allow it to win wars faster, cheaper, and more decisively. Characteristic of this view was defense analyst James Blaker's statement: "The potency of the American RMA stems from new military systems that will create, through their interaction, an enormous military disparity between the United States and any opponent. Baldly stated, U.S. military forces will be able to apply military force with dramatically greater efficiency than an opponent, and do so with little risk to U.S. forces."[25]

The confidence, even hubris, of the 1990s permeated the U.S. officer corps.

The Growth & Spread of the Precision-Strike Regime

Officers in the late 1990s perceived the benefits of transformation, but refused to believe that adversaries could acquire precision-strike capabilities themselves. A survey of 1,900 U.S. officers attending professional military education institutions conducted in 2000 found that most tended to believe that the emerging RMA would make it easier for the United States to use force in order to achieve decisive battlefield victories. Most also believed that it would allow the United States to engage in high-intensity operations with substantially reduced risk of casualties and that it would greatly reduce the duration of future conflicts. They also tended to believe that the United States would have a greatly enhanced ability to locate, track, and destroy enemy forces in limited geographic areas.[26] By contrast, these same officers were skeptical of the ability of potential adversaries to exploit the precision-strike revolution to harm the United States. For example, only 9 percent of officers surveyed in 2000 believed that future adversaries would be able to use long-range precision-strike weapons such as ballistic and cruise missiles to destroy fixed military infrastructure, including ports, airfields, and logistical sites; only 12 percent believed they would be able to use such weapons to attack carrier battle groups at sea.[27]

The 1999 war over Kosovo saw the introduction of a new generation of PGMs guided by data from the Global Positioning System (GPS) satellite constellation, most notably the GBU-31 Joint Direct Attack Munition (JDAM). The weapon consists of a $20,000 kit, including a GPS receiver, sensors, and tailfins, that converts an unguided bomb into a guided weapon. In contrast with the LGBs used in Vietnam and the Gulf War, such weapons allow aircraft to strike at night and through inclement weather. The Kosovo war also saw the use of UAVs, such as the Air Force RQ-1A *Predator*, for reconnaissance and surveillance.

At the dawn of the new millennium, however, concern mounted that the precision-strike revolution, once an American monopoly, was on the verge of spreading. Of particular concern was China's development of so-called anti-access/area-denial capabilities. Reflecting this concern, the 2001 *Quadrennial Defense Review*, issued in the wake of the September 11, 2001, terrorist attacks, argued that the Defense Department's transformation efforts should focus on overcoming six emerging strategic and operational challenges:

- Protecting critical bases of operations, including the U.S. homeland, forces abroad, allies, and friends, and defeating weapons of mass destruction and their means of delivery;
- Assuring information systems in the face of attack and conducting effective information operations;
- Projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats;
- Denying enemies sanctuary by providing persistent surveillance, tracking, and rapid engagement with high-volume precision strike against critical mobile and fixed targets;
- Enhancing the capability and survivability of space systems and supporting infrastructure; and
- Leveraging information technology and innovative concepts to develop an interoperable, joint C4ISR architecture and capability that includes a joint operational picture that can be tailored to user needs.[28]

This shift was reflected in officer attitudes. In 2000, the vast majority of officers had been unconcerned about the full spectrum of threats; those surveyed in 2002 and 2006 expressed obvious concern about a range of future threats over the next two decades. Officers now worried about the threat from long-range precision-strike missiles with respect to current platforms and deployment schemes, with 69 percent of officers surveyed in 2002 and 2006 predicting that within a decade, adversaries would be able to use ballistic and cruise missiles to deny the United States the use of ports, airfields, and logistical sites. Similarly, 73 percent of officers surveyed in 2002 and 68 percent in 2006 believed that within a decade, adversaries would be able to use such weapons to attack carrier battle groups at sea.[29]

Between 1991 and 2003, PGMs grew from a niche capability to represent a new standard of warfare. Whereas 8 percent of the munitions employed during the Gulf War were guided, 29 percent of those used over Kosovo eight years later, 60 percent of those used in Afghanistan ten years later, and 68 percent of those used in Iraq twelve years later were guided. In Afghanistan, the JDAM became the weapon of choice for U.S. forces. Between October 2001 and February 2002, U.S. forces dropped 6,600 of the munitions; during just one ten-minute period on October 18, 2001, the Air Force dropped a hundred of the bombs. Two years later in Iraq, U.S. forces dropped more than 6,500 JDAMs in the march on Baghdad.[30]

Precision weaponry has also assumed an important role in the panoply of weapons to combat terrorism. The decision to arm the *Predator* UAV and use it against Al Qaeda came in 2000, and the weapon was quickly pressed into use after the September 11, 2001, terrorist attacks. In November 2002, an AGM-114A *Hellfire* air-to-surface missile launched by a *Predator* destroyed a car carrying six terrorists, including Salim Sinan al-Harethi, Al Qaeda's chief operative in Yemen and a suspect in the October 2000 bombing of the destroyer USS *Cole*. Most of the strikes that followed targeted Pakistan's lawless border region. Begun by the George W. Bush administration, the program has reportedly been expanded by the Obama administration. According to one estimate, U.S. drones, including the *Predator* and the more powerful MQ-9 *Reaper*, have carried out more than 150 strikes in Pakistan since 2008, killing a number of senior Al Qaeda leaders as well as Baitullah Meshud, the head of the Pakistani Taliban. More controversial has been the death toll among innocents resulting from the attacks, but these deaths appear to be declining dramatically even as the number of strikes has increased, in part due to the deployment of new munitions with an even smaller warhead than that on the *Hellfire*.[31]

Despite – or, in fact, because of – America's success in embracing the precision-strike revolution, the United States is losing its military edge. Adversaries are acquiring PGMs, as well as the vital supporting capabilities needed to wage precision warfare, including commercial sources of imagery, precision navigation and timing, and upgraded command and control. Moreover, states are developing the ability to counter U.S. precision-strike capabilities by hardening, concealing, and dispersing their forces and infrastructure. We are, in other words, currently experiencing the maturation of the precision-strike revolution and the emergence of the precision-strike regime.

A growing number of actors are acquiring PGMs. These include not only U.S. allies, but also competitors such as China, which has become a leading player in the

precision-strike regime. Unconstrained by the Intermediate-Range Nuclear Forces (INF) Treaty, which prevents the United States and Russia from deploying land-based intermediate-range missiles, China has become the world leader in precision-guided ballistic missiles. According to unclassified Defense Department estimates, China has deployed more than one thousand precision-guided conventional ballistic missiles opposite Taiwan. Moreover, it is preparing to field an anti-ship ballistic missile capable of striking ships at sea up to 1,500 km from China.[32] Nor are states any longer the only actors in the precision-strike revolution. For example, Lebanese Hezbollah used anti-tank guided missiles against Israeli forces in its 2006 war with Israel.[33] More recently, Hamas used such a weapon against an Israeli school bus.

We should not be surprised by the spread of precision-strike capabilities. It was historically inevitable, even if the process has been accelerated by the commercial availability of key supporting capabilities, such as imagery and command and control. Of greatest significance, however, is the universal free access to precision navigation and timing data, such as that from the U.S. GPS satellite constellation. Whereas the development of precision guidance cost the United States billions of dollars over the course of decades, both states and non-state actors can now strike accurately with a minimum investment.

As other states are increasing their precision-strike capabilities, the United States is devoting less attention to precision strike than it has in the past. Rather, for the last half-decade the Defense Department has focused on countering insurgency in Iraq and Afghanistan – conflicts where precision strike plays a role, to be sure, but not a central one.

Meanwhile, both states and non-state actors, such as insurgents and terrorists, are seeking to counter U.S. precision-strike capabilities. Insurgents in Afghanistan and Pakistan, for example, have sought to camouflage themselves and hide among the local population. They have also sought to constrain the ability of the United States to bring airpower to bear by falsifying the number of innocents who have been killed in air strikes.[34]

If history is a guide, the future scope and spread of the precision-strike regime will be uneven. The ability of states and non-state actors to deploy an effective precision-strike capability will depend on their ability not only to field weapons, but also to develop or buy the command and control and intelligence, surveillance, and reconnaissance capabilities that are needed to strike with precision as well as to develop appropriate doctrine and operational concepts for their use. They will also seek ways to circumvent our precision-strike capability.

At the strategic level, states and non-state actors alike will be driven to adopt some combination of precision-strike and adaptive countermeasures. At the operational level, the interaction between the development of precision-strike systems, on the one hand, and attempts to protect against them, on the other, will drive the maturation of the precision-strike regime. Precision-guided weapons are putting an expanding range of targets at risk. It is already possible to effectively strike targets that were previously invulnerable. That trend is likely to continue. At the same time, the emergence of precision-strike systems is already leading adversaries to try to protect targets by making them mobile, as well as hardening, burying, defending, camouflaging, or concealing them.

Over time, this offense-defense interaction will render some targets difficult, if not impossible, to strike. Mobile weapons based deep in a nation's territory, deployed

in the deep oceans or underwater, and located at great distances from attackers may remain for all intents and purposes invulnerable. More broadly, military forces will adopt measures to reduce their vulnerability. However, some targets cannot be buried or made mobile and will thus remain vulnerable. These will include civilian infrastructure such as electrical power distribution and oil refineries, but also military infrastructure, such as ports, bases, and logistical depots. Because of the enduring asymmetry between strike and protection, long-range precision-strike campaigns could increasingly come to target an adversary's vulnerable homeland infrastructure rather than his less vulnerable armed forces. Indeed, the twenty-first century may witness the resurrection, or transfiguration, of doctrines of strategic bombing, such as those that Italian Army General Giulio Douhet espoused at the beginning of the twentieth century, and theories of coercion, such as those economist and strategist Thomas Schelling advanced during the Cold War.

In a world where many states possess precision-strike systems, traditional conquest and occupation will become much more difficult. They may, in fact, become prohibitively expensive in some cases. Imagine, for example, if the Iraqi insurgents had been equipped with precision-guided mortars and rockets and had reliably been able to target points within Baghdad's Green Zone. Or imagine that the Taliban were similarly armed and were thus able to strike routinely the U.S. and Afghan forward operating bases that dot the Afghan countryside. U.S. casualties could have amounted to many times what they have been in either theater.

Because invasion and conquest are becoming increasingly difficult, wars in a mature precision-strike regime will likely focus on coercion and limited political objectives. In this world, the ability to punish an adversary to force him to concede – what Thomas Schelling dubbed the "power to hurt" – is likely to become an increasingly popular theory of victory.[35] One potential result of this strategic interaction would be conflicts that involve campaigns whereby each side uses precision-strike weapons to hold the other's economic and industrial infrastructure at risk. In such a situation, stability would depend on each side possessing an assured survivable retaliatory capability. Unlike the condition of mutual assured destruction that obtained during the Cold War, however, this retaliatory capability could be based on precision-strike systems rather than nuclear weapons.

A mature precision-strike regime would feature a new set of "haves" and "have-nots," with an actor's status determined by the robustness of its precision-strike capability rather than other attributes, such as the possession of nuclear weapons. The precision-strike haves will be those countries that possess both geographic depth as well as the resources to invest in survivable, effective precision-strike systems. They will likely include the United States, China, India, and potentially Russia. The precision-strike have-nots will be those countries that are threatened by precision-strike systems but that lack the geographic depth or resources to invest in a survivable, effective precision-strike capability, such as Japan and Taiwan. These states will have incentives to invest in other forms of warfare, such as nuclear weapons.

The growth and diffusion of precision-strike systems could also affect international relations more broadly. To the extent that U.S. military power in general, and power projection in particular, has underpinned global norms, the emergence of anti-access capabilities could undercut world order. For example, the develop-

ment and diffusion of anti-access systems could undermine the principle of freedom of navigation. In other cases, actors could seek to limit precision-strike capabilities. It is not inconceivable, for example, that states or non-state actors could seek to curb precision-strike systems through an international treaty, much as land mines have been limited. Amnesty International has already decried the U.S. drone campaign over Pakistan, and the United Nations Special Rapporteur on Extrajudicial Killings, Philip Alston, has condemned it and called for greater "accountability" to prevent what he called a "slippery slope" of killing.[36] Future attempts to proscribe the use of such unmanned systems are not beyond the realm of possibility.

Precision-strike systems are already affecting expectations regarding the use of force, and that trend is likely to continue. The ability of weapons to destroy targets reliably and accurately has fostered the notion in many countries that war is a bloodless and error-free undertaking. In such an environment, targeting errors – the U.S. strike on the Chinese embassy in Belgrade in 1999, for instance – are likely to be perceived as deliberate acts.

The advent of precision strike and UAVs has separated warriors mentally and physically from the act of killing. Dropping unguided weapons required considerable skill to ensure that the bomb struck near (let alone on) the target. Delivering LGBs similarly required the operator to designate the target with a laser and keep it illuminated throughout the bomb's flight, a process that took seconds. Delivering a GPS-guided bomb merely requires the operator to input the target's coordinates into a computer. Similarly, UAV operators are physically removed from combat. The pilots who operate *Predators* and *Reapers* launching missiles over Pakistan are as far distant from the battlefield as Creech Air Force Base in Nevada. They report for work and routinely locate, identify, and track terrorists; sometimes they fire missiles and kill them. They then leave work and return home to their families at the end of every shift. This arrangement represents a profound change in the relationship between the warrior and warfare, one whose implications are only now beginning to play out.

The emergence of a mature precision-strike regime is likely to have dramatic consequences for the United States. Since the end of World War II, the United States has based its defense strategy on a combination of forward-based forces to deter adversaries and reassure allies and friends and the projection of power from those bases and the continental United States to defeat foes in wartime. The spread of precision-strike systems will call that formula into question.

U.S. bases are increasingly under threat of precision-strike systems. For example, some U.S. bases in the western Pacific are now within range of Chinese precision-guided conventional ballistic missiles; others will come in range as China deploys longer-range weapons. Over time, the vulnerability of these bases will undermine the deterrence of aggressors and reassurance of allies.

The threat to U.S. forward bases, in turn, calls into question the model that the United States has relied on for power projection in recent decades. Without access to ports and airfields in Saudi Arabia and across the Persian Gulf region, for example, it would have become considerably more difficult for the U.S.-led coalition to eject Iraqi forces from Kuwait in 1991. A future campaign against an adversary armed with precision-guided missiles, rockets, and mortars may more closely resemble the Normandy invasion and Iwo Jima than the relatively unopposed attacks on Iraq and Afghanistan.

Finally, over time it is likely that states will be able to strike the U.S. homeland with precision-strike systems, offering them a way to attack the United States directly. This threat could further increase the cost of U.S. intervention overseas and potentially offer adversaries a way to coerce the United States without resorting to the use of nuclear weapons.

However it manifests itself, the emergence of a mature precision-strike regime is likely to result in a pattern of conflict that will differ considerably from that of recent decades. The United States will no longer be able to rely on its absolute superiority in precision strike for battlefield advantage. To compete, the United States will have to seek new sources of comparative advantage. Ironically, it may also have to revert increasingly to its nuclear arsenal to deter not only nuclear attacks, but also strikes from precision-guided non-nuclear weapons. Here as in other areas, old ideas may reappear in new form as the revolution matures.

ENDNOTES

[1] See Bernard Brodie, "Technological Change, Strategic Doctrine, and Political Outcomes," in *Historical Dimensions of National Security Problems*, ed. Klaus Knorr (Lawrence: University Press of Kansas, 1976); J.F.C. Fuller, *Armament and History: A Study of the Influence of Armament on History from the Dawn of Classical Warfare to the Second World War* (London: Eyre & Spottiswoode, 1946); Karl Lautenschäger, "Technology and the Evolution of Naval Warfare," *International Security* 8 (2) (Fall 1983); William H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society Since AD 1000* (Chicago: University of Chicago Press, 1982); Jeremy Black, *A Military Revolution? Military Change and European Society, 1550 – 1800* (London: Macmillan, 1991); Geoffrey Parker, *The Military Revolution*, 2nd ed. (Cambridge: Cambridge University Press, 1996); Clifford J. Rogers, ed., *The Military Revolution Debate: Readings on the Military Transformation of Early Modern Europe* (Boulder, Colo.: Westview Press, 1995); Keith L. Shimko, *The Iraq Wars and America's Military Revolution* (Cambridge: Cambridge University Press, 2010), chap. 1.

[2] Andrew F. Krepinevich identifies the following military revolutions: (1) the infantry revolution of the first half of the fourteenth century; (2) the artillery revolution of the early to mid-fifteenth century; (3) the revolution of sail and shot that stretched from the sixteenth century to the mid-seventeenth century; (4) the fortress revolution of the sixteenth century; (5) the gunpowder revolution of the seventeenth century; (6) the Napoleonic revolution of the late eighteenth and early nineteenth centuries; (7) the land warfare revolution that stretched from the mid-nineteenth century to the early twentieth century; (8) the naval revolution that stretched from the mid-nineteenth century to the early twentieth century; (9) the interwar revolutions in mechanization, aviation, and information of the early twentieth century; and (10) the nuclear revolution of the mid-twentieth century. Andrew F. Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," *The National Interest* 37 (Fall 1994): 31 – 36.

[3] Eliot A. Cohen, "A Revolution in Warfare," *Foreign Affairs* 75 (2) (March/April 1996): 43 – 44.

[4] See, for example, Rolf Hobson, "Blitzkrieg, the Revolution in Military Affairs and Defense Intellectuals," *The Journal of Strategic Studies* 33 (4) (August 2010): 625 – 643.

[5] There is a considerable literature on the issue of military innovation. See Adam Grissom, "The Future of Military Innovation Studies," *The Journal of Strategic Studies* 29 (5) (October 2006): 905 – 934; Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Ithaca, N.Y.: Cornell University Press, 1984); Stephen Peter Rosen, "New Ways of War: Understanding Military Innovation," *International Security* 13 (1) (Summer 1988); Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Mili-*

tary (Ithaca, N.Y.: Cornell University Press, 1991); Kimberly Marten Zisk, *Engaging the Enemy: Organizational Theory and Soviet Military Innovation, 1955–1991* (Princeton, N.J.: Princeton University Press, 1993).

6 The Napoleonic revolution, for example, was not brought about by technological innovation, nor did it involve new weaponry. See Peter Paret, "Revolutions in Warfare: An Earlier Generation of Interpreters," in *National Security and International Stability*, ed. Bernard Brodie, Michael D. Intriligator, and Roman Kolkowicz (Cambridge: Oelgeschlager, Gunn, and Hain, 1983), 158.

7 See, for example, the cases in Williamson Murray and Allan R. Millett, eds., *Military Innovation in the Interwar Period* (New York: Cambridge University Press, 1996).

8 Michael Howard, "Military Science in an Age of Peace," *Journal of the Royal United Services Institute for Defence Studies* 119 (1) (March 1974): 4.

9 Anchoring occurs when the mind uses a natural starting point as a first approximation to a judgment. It modifies this starting point as it receives additional information. Typically, however, the starting point serves as an anchor that reduces the amount of adjustment, so that the final estimate remains closer to the starting point than it ought to be. Amos Tversky and Daniel Kahneman, "Anchoring and Calibration in the Assessment of Uncertain Quantities," *Oregon Research Institute Research Bulletin* 12 (1972).

10 Everett M. Rogers, *Diffusion of Innovations*, 3rd ed. (New York: Free Press, 1983), 175.

11 Fuller, *Armament and History*, 143.

12 *Jeune école* tactics did not, for example, displace the battleship as the centerpiece of naval warfare. Nor have anti-tank weapons made the tank obsolete. Instead, in each case the development of countermeasures triggered responses that restored the effectiveness of the practice that was being countered. See Edward N. Luttwak, *Strategy: The Logic of War and Peace* (Cambridge, Mass.: Belknap Press of Harvard University Press, 1987), 27–39; Robert L. O'Connell, *Of Arms and Men: A History of War, Weapons and Aggression* (New York: Oxford University Press, 1989), 7–9; Michael Vlahos, "A Crack in the Shield: The Capital Ship Under Attack," *Journal of Strategic Studies* 2 (1) (May 1979).

13 Emily O. Goldman and Leslie C. Eliason, eds., *Adaptive Enemies, Reluctant Friends: The Impact of Diffusion on Military Practice* (Stanford, Calif.: Stanford University Press, 2003).

14 See, for example, Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008); Thomas G. Mahnken, *Uncovering Ways of War: U.S. Military Intelligence and Foreign Military Innovation, 1918–1941* (Ithaca, N.Y.: Cornell University Press, 2002).

15 Thomas G. Mahnken, "Beyond Blitzkrieg: Allied Responses to Combined-Arms Armored Warfare During World War II," in *Adaptive Enemies, Reluctant Friends*, ed. Goldman and Eliason.

16 Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2007).

17 Mahnken, *Technology and the American Way of War*, 115.

18 See, for example, William J. Perry, "Desert Storm and Deterrence," *Foreign Affairs* 70 (4) (Fall 1991): 66–82; Krepinevich, "Cavalry to Computer"; and Cohen, "A Revolution in Warfare."

19 Mahnken, *Technology and the American Way of War*, 169, 171.

20 Shimko, *The Iraq Wars and America's Military Revolution*, 23.

21 Michael J. Mazarr et al., *The Military Technical Revolution: A Structural Framework* (Washington, D.C.: Center for Strategic and International Studies, 1993), 28.

[22] Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, D.C.: Department of the Air Force, 1993), 251.

[23] William S. Cohen, *Report of the Quadrennial Defense Review* (Washington, D.C.: Department of Defense, 1997), iv.

[24] *Transforming Defense: National Security in the 21st Century* (Arlington, Va.: National Defense Panel, December 1997).

[25] James R. Blaker, "The American RMA Force: An Alternative to the QDR," *Strategic Review* (Summer 1997): 22.

[26] Thomas G. Mahnken and James R. FitzSimonds, *The Limits of Transformation: Officer Attitudes Toward the Revolution in Military Affairs* (Newport, R.I.: Naval War College Press, 2003), chap. 6.

[27] Ibid., chap. 7.

[28] *2001 Quadrennial Defense Review Report* (Washington, D.C.: Department of Defense, 2001), 30.

[29] James R. FitzSimonds and Thomas G. Mahnken, "Officer Attitudes Toward Transformation, 2000–2006," paper presented at the Annual Meeting of the International Studies Association, March 24, 2006, San Diego, California.

[30] Mahnken, *Technology and the American Way of War*, 200, 209.

[31] Brian Glyn Williams, "The CIA's Covert Predator Drone War in Pakistan, 2004–2010: The History of an Assassination Campaign," *Studies in Conflict and Terrorism* 33 (10) (October 2010): 871–892; "A New Weapon in the War on Terror," *Newsweek* blog, http://www.newsweek.com/blogs/declassified/2010/09/10/a-new-weapon-in-the-war-on-terror.html (accessed December 9, 2010).

[32] *Military and Security Developments Involving the People's Republic of China* (Washington, D.C.: Department of Defense, 2010).

[33] Lieutenant Colonel Scott C. Farquar, *Back to Basics: A Study of the Second Lebanon War and Operation CAST LEAD* (Fort Leavenworth, Kans.: Combat Studies Institute Press, 2009).

[34] Williams, "The CIA's Covert Predator Drone War in Pakistan," 880–882.

[35] Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966), 2.

[36] Williams, "The CIA's Covert Predator Drone War in Pakistan," 881–882.