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NUMBER THIRTEEN

FROM GETTYSBURG TO THE GULF AND BEYOND

COPING WITH REVOLUTIONARY TECHNOLOGICAL CHANGE IN LAND WARFARE

By RICHARD J DUNN III

THE INSTITUTE FOR NATIONAL STRATEGIC STUDIES

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INTRODUCTION: COPING WITH TECHNOLOGICAL CHANGE

 ODAY, AT THE CLOSE OF THE TWENTIETH CENTURY, technology is changing at a pace without precedence in human history. One day's marvel becomes a necessity of ordinary life the next. Rapid technological change permeates the whole of human existence, exhausting our mental ability to comprehend and cope.

In the military realm, we have won the most technologically sophisticated war ever fought. With lightning speed, high-tech weaponry annihilated a massive Iraqi force while the world watched minute-by-minute from its living rooms, leading to a fundamental question of critical importance to the armed services and the nation: *How does our military—as an institution—deal with technological change?* How well have we done it in the past, and how well are we prepared to do it in the future? What approach should we use? How do we even frame the issues?

Herein lies the subject of this paper. Readers who seek exciting acronym-spiced accounts of futuristic battles fought with their favorite high-tech weaponry are encouraged to look elsewhere. The issue here is much more mundane—and much more important—than specific applications of technology: it is, rather, our basic ability to comprehend the total impact of technology on warfare. If, however, you suspect this issue is dull and uninspiring stuff, let me conjure up a few mental images for you.

—Pickett's Brigade, arrayed as if on parade in ordered gray and butternut ranks behind their tattered but proud colors, mown down in their thousands on a warm July day at Gettysburg.

—The youth of the British Empire, dying by entire regiments in front of barbed wire and machine guns along the Somme.

—The British Expeditionary Force, standing stoically shoulder deep in the sea like human piers at Dunkirk.

—Crazily tilted masts of the sunken US Battleship *Arizona* emerging from the roiling masses of black smoke at Pearl Harbor.

—Lines of twisted and burnt Iraqi tank hulks stretching from horizon to horizon across the sands of Kuwait.

These examples are the consequences of failing to understand the impact of technological change. This stuff is not dry, suited only to academicians in ivory towers, but the stuff that seals the fates of armies and empires, the ink of military history, something that soldiers ignore only at great peril. Therefore, I have made this effort with three overriding goals in mind:

—To lay out an approach to understanding the impact of technological change on warfare.

—To apply this approach to today's circumstances.

—To propose a strategy for seizing the advantages and avoiding the dangers that technological change presents today.

Technological change of the order and magnitude of interest here affects all the armed services and all modes of warfare. To keep the study within meaningful and manageable bounds, I've focused the investigation in the area of my own expertise, the Army and land warfare. But the effects of changing technology are so far-reaching that few other issues will weigh so heavily on the Army—and the military as a whole—as we move into the twenty-first century.

Let me begin by introducing some basic concepts: the distinction between evolutionary and revolutionary change and the power of the military paradigm.

IN THE SUMMER OF 1940, GERMANY UNLEASHED a powerful new model of warfare on the world. Its *blitzkrieg* shattered both the supposedly preeminent Allied armies and conventional ideas of warfare. In December 1941, Japanese naval aviation turned the battle line of the US Pacific Fleet into a

collection of smoldering hulks, ending forever the centuries-long dominance of the battleship. Military history is punctuated by similar instances during which the military giant of the day has had its legs kicked out from under it by some second-ranked (or even unranked) power using a "new" form of warfare that catches the giant by surprise. Why do these experiences happen?

Much blame can be assigned to general unpreparedness, lack of motivation, and overall ineptitude of the dominant power—clay feet are readily exposed when bullets start to fly for real. But much blame also falls on the basic inability of dominant military establishments—wedded to past success—to understand the new form of warfare until they are lying flat on their backs.

Evolution vs Revolution. In France, at Pearl Harbor, and at other critical times and places in military history, major disruptions have occurred in warfare's otherwise smooth and evolutionary development. Frequently responding to technological change, these moments have dealt deathblows to contemporary concepts of warfare. Slow, steady improvements in doctrine, tactics, and weapons have suddenly given way to rapid change in the basic nature of warfighting.

What we're considering here is the difference between "normal" *evolutionary* change and dramatic *revolutionary* change. In evolutionary change, progress is made by improving on the last generation of something—a tool, a process, a thought, a weapon, whatever. Sometimes progress can be very impressive, but continuity still exists between generations. In revolutionary change, almost no continuity exists between generations—we're looking at something entirely new.

In revolutionary changes in warfare, forces that have recognized and exploited these changes have usually defeated forces that didn't, making for much more than an interesting footnote to military history. Revolutionary change in the basic nature of warfighting has posed—and could pose again—a grave threat to the nation. Unfortunately, our Defense Establishment's bureaucratic nature makes it ill-equipped to deal with this type of revolutionary change—bureaucratic organizations are best suited to deal with evolutionary change. But deal with it we

must, for increasingly rapid technological change—as evidenced by the Gulf War—may have already placed the world on the brink of another major shift in the nature of warfare.

The Paradigm Shift. Lack of an analytical framework is a major source of difficulty in understanding these revolutionary changes in warfare. But a noted scientific philosopher, Thomas Kuhn, has done some insightful work on revolutionary change in the physical sciences that can provide a useful model for understanding revolutionary change in warfare. In his book, *The Structure of Scientific Revolutions*, Kuhn develops the concept of a "paradigm shift." A paradigm, or model, he says, is the common set of beliefs shared by scientists in any field.[1] "Normal science" is carried out under this set of beliefs, and slow progress is made. Only when this dominant paradigm is challenged by a newer, more useful one is true *revolutionary* progress made.[2]

Kuhn's favorite example is the sixteenth century revolution in astronomy. Until then, astronomers shared the Ptolemaic view of the universe—that all other heavenly bodies orbited the earth. However, astronomical observations increasingly conflicted with Ptolemaic predictions. To eliminate the conflict, Copernicus developed his revolutionary theory that the earth and all other planets orbited the sun. Great tumult rocked the fields of astronomy and religion, but great progress was made.[3] The debate was finally settled in favor of Copernicus, and a paradigm shift occurred.

But what actually happened? Copernicus made no great new discoveries. Instead, he looked at well-known facts from a new perspective and came up with a *simpler, more useful* model. His paradigm explained the universe a lot better than the old one. The theory of relativity in physics and plate tectonics (continental drift) in geology are examples of continuing paradigm shifts in the physical sciences. Most recently, even the somewhat stuffy field of paleontology has been set afire by the thesis that massive asteroid strikes caused past mass extinctions of the dinosaurs.

Military Paradigms. Kuhn's work, which has been highly useful in understanding the development of scientific thought, also can provide a useful framework for understanding revolutionary

changes in military thinking. Kuhn defines a "paradigm" as the common set of beliefs shared by scientists working in any given field. The military community has its equivalent set of beliefs that form the "bedrock" understanding of the way the military world works. Doctrine, strategy, tactics, techniques, defense programs, and weapon systems—all are developed from this set of fundamental "truths."

Some examples of military paradigms are:

—Belief in the superiority of defense over offense in land warfare that dominated Western military thought after World War I.

—Faith in firepower and shock action applied at the point of decision by massed mechanized forces—the heart of *blitzkrieg* doctrine.

—Pre-Pearl Harbor belief in the battleship as the centerpiece of the fleet, the key element in naval force projection.

—Mutual Assured Destruction—the basis for nuclear deterrence among the superpowers today.

Any particular military establishment at any particular time *always* has a dominant paradigm made up of such fundamental "truths" commonly shared throughout the establishment.

Power of the Paradigm. Consider the power of these dominant paradigms:

—As fundamental truth, they are the basis for everything we do.

—Doctrine, strategy, tactics—all are efforts to exploit these basic truths.

—Forces and weapons are developed to execute strategies and tactics.

—Industries and communities—and their associated political constituencies—grow up around these forces and weapons.

—Officers are promoted for their abilities to master doctrine, strategy, and tactics—or to develop and field new weapon systems—based on the paradigm.

—Training and professional writing (for the most part) is done within the context of the paradigm.

The sum of all this "paradigm power" is that the entire military establishment has a tremendous amount of "capital"

invested in its dominant paradigm, with a consequent reluctance to alter the paradigm in any way. While *evolutionary* progress is made within the context of the paradigm, only a major shock or external force can lead to *revolutionary* change in the paradigm itself. Thus, inertia is a common characteristic of military establishments that view themselves as successful and remain unchallenged by a superior threat.

Danger of the Inappropriate Paradigm. However, we don't mean to say that dominant paradigms are necessarily either wrong or bad. In fact, an effective military establishment would be impossible without a common understanding of the way the world works. However, military establishments get themselves into grave trouble when they fail to review the appropriateness of their current paradigm in view of the total environment—military, technological, and political—in which they operate. Paradigms that work fine in one environment, usually the one in which they develop, often prove disastrous in other environments. If the paradigm—the basic understanding of the way things work—is wrong, then doctrine, strategy, tactics, force structure, and weaponry will inevitably be flawed.

Redcoats and Redskins: Take a case familiar to every student of American history—Braddock's Defeat. Leading a force of British regulars and colonial militia against the French-held Fort Duquesne (near present-day Pittsburgh) in 1755, General Edward Braddock was ambushed and soundly defeated by a much smaller force of French and Indians. Braddock's regulars, in their red coats and crossed white belts, stood shoulder-to-shoulder in formal line of battle and were picked off in droves by fierce Indians and a few Frenchmen hiding behind trees and rocks.[4]

Since colonial times Braddock's Defeat has commonly been treated as an example of British thickheaded obtuseness and Braddock's ineptitude. However, there is much more to it than that. Braddock was actually a competent officer with a solid professional reputation. His organization of the expeditionary force (it sailed from Ireland), integration of colonial militia troops, and methodical approach march through the trackless wilderness were really quite impressive. His two regular Irish regiments were

relatively well led, with many experienced soldiers.[5] Unfortunately, all of their experience had been in Europe, where open terrain, inaccurate muskets, and unwilling soldiers forced armies to line up in orderly, multi-rank lines to fit as much firepower into a given space as possible.[6] Thus, Braddock's operative paradigm was of linear, European open-field warfare.

And there was nothing basically wrong with this paradigm. It had developed over the previous century in Europe and held there for more than another century. Another British general, James Wolfe, used it to great effect in his decisive victory against Louis-Joseph de Montcalm at Quebec during the same war.[7] Even George Washington, who was one of the few heroes of Braddock's defeat, essentially employed linear open-field warfare later throughout the Revolutionary War.

Braddock's basic problem—viewed from the paradigm perspective—was that he did not recognize that his model for warfighting would not work in a forested wilderness against an uncivilized foe who would not stand up and take their bullets like gentlemen: it was inappropriate for the environment in which it was employed.

G.I.s and the Viet Cong: Unfortunately, Braddock was not history's only victim of an inappropriate paradigm. Much of the difficulty the US Army faced early on in Vietnam is directly attributable to what Andy Krepinevich called the "Army Concept," the Army's perception of how wars *ought* to be fought—the Army's operative paradigm. In his well-researched book, *The US Army in Vietnam,* he describes an Army organized and trained to fight according to a concept based on its World War II experience in Europe. Consequently, the Army was prepared to fight a conventional, mechanized war highly dependent on heavy firepower to minimize casualties, but not the war or enemy the Army faced in Southeast Asia: the hard-bitten Viet Cong and North Vietnamese, steeped in the revolutionary thought of Ho Chi Minh and Mao Ze-dong. The US Army, Krepinevich writes, needed a paradigm based on

> light infantry formations, not heavy divisions; on firepower restraint, not its widespread application; on the resolution of

> political and social problems within the nation targeted by insurgents, not closing with and destroying the insurgent's field forces.[8]

The Obsolete Paradigm: Blueprint for Disaster. By definition, a paradigm is the set of "truths" on which the world operates. Braddock and our Army in Vietnam shared the common failing of employing paradigms that were not broad enough to cover the "truths" of the particular environment they were used in, and thus were not appropriate to the circumstances at hand. However, what happens when the "truth" changes—as all good politicians and personnel managers tell you it will? What happens when a basic change in the underlying technological, political, or other factors renders the popular "truth" obsolete? How do we update our perception of "truth"?

The scientific community has a difficult but highly productive time when people begin to doubt the old "truth" and a "new truth" is proposed to challenge it. As Kuhn explains in his paradigm shift thesis, the way things play out has some logic. The statement of the new thesis causes great argument and controversy—and drives both sides to search for tangible evidence to support or attack the new thesis.[9] For example, the theory of continental drift was ridiculed when it was first proposed, but statements of the theory led to lively arguments for and against it. Supporters of the theory searched for evidence to support their position that continents did, in fact, drift over long periods of time. They searched for and eventually found matching geological features on separate continents and finally actually measured the continental movement with satellites. The theory was proven, "truth" in the field of geology changed—a paradigm shift occurred.

The military world faces much greater difficulty in dealing with changing truth. While scientists can conduct experiments and research to prove the new paradigm, the only way to conclusively prove a new military paradigm is for a force fighting according to the new paradigm to defeat a force that hangs onto the old. Unfortunately (at least from the perspective of development of military theory), major wars among the modern, industrialized nations are rare events. No major power has fought

another since World War II. Consequently, there is a danger that dominant military paradigms will become obsolete if they remain unchallenged for long periods of time. Technological change may make their underlying assumptions invalid, but without the test of battle this danger may remain unrecognized. At this point, two things can happen. Both sides can continue with paradigms that do not reflect change, with the consequence usually being an extremely bloody and expensive war, in which neither side achieves its war aims at a reasonable cost. Or one side can recognize change and develop a new paradigm incorporating it, usually achieving a significant initial advantage over its adversary, who adopts the new paradigm only after a major disaster.

Obviously, the process of adapting to change by forging a more effective paradigm should be of grave concern to any serious military establishment. How are new paradigms formed? How do major powers adopt them to achieve a critical initial advantage over their adversaries? The fate of nations literally rides on these questions. Fortunately, a bit of historical hindsight can shed some light on the answers.

II. SOME LESSONS FROM HISTORY

ACH GENERATION LOOKS AT HISTORY through the tinted lenses of its own time and experience. Moreover, writers who use history to "prove" a thesis run the risk of selecting only those cases that support the thesis and ignoring the cases that don't. Unfortunately, students of military theory must put up with these shortcomings, for military history is the sole "data base" for supporting our thinking. To compensate, we need to recognize that each case is historically unique and that we must be cautious in generalizations we draw from them.

Even with this warning in mind, history can teach quite a bit about how military establishments adapt to technological change and the consequences of this adaptation. While technology and societies can change rather rapidly, human nature tends to change much more slowly. Because our establishments are made up of people, looking at how they have adapted to change in the past can provide useful guidelines for successful adaptation in the future.

COST OF OBSOLETE PARADIGMS: HIGH PRICE OF GLORY

In history, as in life, failure is often a better teacher than success. Therefore, it is useful to look first at several historic failures to adapt effectively to technological change and the consequences of these failures. One of the gravest and most expensive mistakes that a nation's military leadership can make is to continue fighting according to a paradigm whose basic tenets have been invalidated by technological progress. Even if the nation wins, victory usually comes at the cost of tremendous damage to the national social fabric. Two excellent historical examples show the terrible consequence of obsolete paradigms.

The American Civil War: Robert E. Lee and the Minie Ball. In a sense, northern victory in the American Civil War—and its tremendous bloodshed—can be directly attributed to the failure of both sides to adapt their operative paradigm of warfare to meet dramatically changed conditions. During the Civil War, the Napoleonic paradigm of warfare (developed during the Napoleonic Wars) dominated military thinking. Overwhelming emphasis was placed on the offense and offensive spirit, strategically embodied in the "mystique" of the climatic battle that crushed the opponent's force in the field, and was the "natural object and climax of any military campaign."[10]

Tactically, this paradigm held that a massed body of well-disciplined, spirited men could charge across the lethal zone of defenders' musket fire to seize almost any position by shock action before the defender could fire a second volley. Thus, offense was believed superior to defense, both strategically and tactically. All the great Civil War leaders on both sides had been raised with this paradigm, and their belief in it had been greatly reinforced by their successes as junior officers during the Mexican War. They carried their unshaken belief in the Napoleonic paradigm with them into the Civil War.

Unfortunately, they neglected one key technological change that occurred between the Mexican War and the Civil War—the introduction of the Minie ball[11] and the rifled musket in the 1850's. Until then, the smoothbore musket had been the preferred infantry weapon. For ease of loading, the ball fired from the musket was kept somewhat smaller than the barrel—the ball could be dropped directly on top of the wad and powder and seated with only a tap of the ramrod—allowing rapid loading and relatively high firepower, preferred by the military leaders of the day. However, it also meant that the ball tended to rattle around in the barrel when the musket was fired. Consequently, a competent marksman could only be depended on to hit a human target at 40 yards or less.

The much more accurate rifle also had been around for some time (recall Daniel Boone and the famous Kentucky long rifle). However, for the rifling (spiral grooves cut in the barrel) to put the stabilizing spin on the rifle ball, the ball had to fit tightly into the grooves. Thus, the ball had to be hammered into

the barrel from the muzzle down—a time-consuming operation. Most infantry units had some riflemen, but they were mostly used as snipers and scouts. The introduction of the Minie ball changed all that. With its hollow base that expanded on firing to fit the rifling, the Minie ball eliminated the need to hammer a ball down a rifle barrel and made it possible to equip all soldiers with rifles without reducing the rate of fire. Because the effective range of the rifled musket was at least 400 yards (about the same as modern infantry rifles), as opposed to the 40-yard effective range of the smoothbore musket, the lethal zone that had to be crossed by an attacker was vastly increased.

These facts were well known before the war—the generals of both sides believed that they understood rifles. After all, they had been around for over 100 years. Prior to the war, the only official tactical change made to meet the greatly increased lethality of the rifled musket was to increase the recommended rate of march of attacking formations from 90 to 120 steps per minute. The terrible casualties of the opening battles taught soldiers to adapt to the new lethality, but the generals never changed their tactics—their only accommodation to the increased carnage of the battlefield was to admit that war was an increasingly bloody business that could only be fought by courageous men. Gen. George E. Pickett's ill-fated charge and numerous other disastrous assaults of fixed positions resulted in part from this failure to adjust military thinking to meet a technological change.[12]

Robert E. Lee subscribed wholeheartedly to the obsolete Napoleonic paradigm, and it may well have cost the South its independence. Lee's faith in Napoleon's example led him to adopt an offensive-defensive strategy—"attacking at some chosen point or points and causing the war to focus there in order to prevent the enemy from attacking everywhere."[13] His strategic objective was always to destroy the enemy army and thereby the Union's will to fight. Tactically, Lee also greatly favored the offense—until resultant heavy losses to his Army of Northern Virginia precluded offensive operations.[14] In favoring the offense in a tactical environment where the much-increased lethality of the rifled musket gave great advantage to the defender, Lee and his brother Confederate generals cost the

South the cream of its manhood along with its bid for independence. Under Lee, the Army of Northern Virginia averaged more than 20 percent casualties in each of its battles—compared to only 15 percent for its relatively manpower-rich Union opponents. At Gettysburg alone, Lee's losses were over 30 percent.[15]

Historical speculation is at best rather dicey, but what might have happened if the South had adopted a defensive strategy, one that recognized the defensive advantage afforded by the new rifled musket? To win, the Union had to subdue the rebellion, and to do that it had to attack. With northern popular support as weak as it was, the immense one-sided "butcher's bill" entailed by offensive operations against a Confederate "defensive defense" might have driven the North to acquiesce to southern independence. If nothing else, the cost in Confederate lives would have been much less. Lee, unfortunately, was not alone in his inability to change his approach to warfare to meet the increased lethality of the rifled musket. Throughout the Civil War, generals on both sides failed to adjust their thinking to meet the new conditions. The consequence was futile attacks of fixed positions that shed blood like water.

The First World War: The Offense Marches On. Bismarck supposedly said that fools learn from their own mistakes—he preferred to learn from the mistakes of others.[16] Unfortunately, European military leaders of the early twentieth century were incapable of following his adage. Despite examples from the American Civil War and the later Russo-Japanese War, Europe clung to the idea that wars would continue to be decided by quick, decisive offensive operations conducted by mass national armies—the old Napoleonic paradigm.[17]

While most European powers understood the implications of many of the new technologies, such as railroads and modern warships, they generally failed to appreciate technologies that led to yet another quantum improvement in defensive capability. Automatic weapons, barbed wire, and improved artillery were all well developed before World War I; but none of the groups that set military doctrine for any of the combatants grasped the implications of these technologies for warfare until their potential had been demonstrated on the battlefield. Even then,

most continued to sacrifice soldiers in a futile effort to achieve "the breakthrough" that would allow their offensively oriented paradigm to operate. J.F.C. Fuller aptly described the consequence:

> Their carefully planned war was...smashed to pieces by firepower...so devastating that...there was no choice but to go under the surface...like foxes. Then...to secure these trenches from surprise...each side...spun hundreds of thousands of miles of steel web around its entrenchments...Armies, through their own lack of foresight, were reduced to the position of human cattle. They browsed behind their fences and occasionally snorted and bellowed at each other.[18]

Only the Germans adapted effectively to the change in warfare by dramatically changing their doctrine and tactics (inspired in part by French writings) during the war; but by the time they applied their new offensive doctrine, their warfighting potential was too depleted to win. (This German effort is described in some detail in section V here.) Consequently, almost all the combatants lost the war, at least in terms of achieving their war aims at anything like an affordable cost. Perhaps the saddest aspect of the loss of a generation of Europe's youth is that the consequences of the new technologies were foreseeable well before the war. In fact, as "unqualified" a military expert as Ivan S. Bloch, a Warsaw banker, predicted in the 1890s that the result of the new firepower would be opening of battles from greater distances, loose formation in attack, strengthening of the defense, and increases in both the area of the battlefield and numbers of casualties. In his *Future of War in Its Technical, Economic, and Political Relations,* he wrote,

> At first there will be increased slaughter...on so terrible a scale as to render it impossible to get troops to push the battle to a decisive issue. They will try to, thinking they are fighting under the old conditions, and they will learn such a lesson that they will abandon the attempt for ever.
>
> The first thing every man will have to do...will be to dig a hole in the ground, and throw up as strong an earthen rampart as he can

> to shield him from the hail of bullets... Battles will last for days, and at the end it is very doubtful whether any decisive victory can be gained.[19]

Bloch was neither eccentric nor isolated in his thinking. In fact, his *Future of War* was responsible in part for the first Hague Peace Conference in 1899. The tragedy of the First World War is that the greatest military minds of the greatest powers were unable to match the intellectual effort of a well-read but totally inexperienced banker.

The Civil War and the First World War are clear-cut examples of the price military institutions pay when they fail to adapt their warfighting paradigms to meet changed conditions. The dominant military powers did adapt to change by adopting the most modern weapons—rifled muskets, machine guns, quick-firing artillery, barbed wire, poison gas, airplanes. However, they continued to employ these *new weapons* according to the *old, offensively oriented paradigms*. The price they paid was enormous: Pickett's corps advancing in ordered gray and butternut ranks, as if on parade behind their regimental colors, mown down by the thousands before they reached the copse of trees at Gettysburg; the flower of a generation of the British Empire's finest, lost in the course of a few summer days along the Somme. Such was the price of offensive glory in a world where the defense was dominant.

THE ADVANTAGE OF GETTING IT RIGHT

If the price of clinging too long to an outdated warfighting paradigm is enormous, so too is the advantage of being the first to shift to a more effective paradigm. On several occasions, military establishments have successfully changed their paradigms to better match the changed technological environments that they would fight in. In doing so, they have achieved significant initial superiority over supposedly stronger foes. These successful forces have essentially exploited opportunities to affect a basic change in the very nature of warfighting. Such exploitation evolves in three steps:

—First, some technological "engine of change" must create the opportunity. For example, new technological developments must be able to provide hitherto unavailable battlefield capabilities that, taken together, have the *potential* to fundamentally change the nature of warfare.

—Second, this potential must be recognized and articulated. An individual or group with both vision and practical military experience must recognize opportunities provided by the "engine of change" and advocate a strategy for seizing these opportunities.

—Third and most important, the opportunity must actually be seized and exploited. A person or group with the *authority* to effect change within a military force must grasp the gravity of the moment and force timely changes, harnessing the full power of the new technology and reorienting the force on a new, more effective paradigm.

Nations that have gone through this process first have achieved significant advantages, leading frequently to military preeminence that lasted at least until their opponents adapted to the new nature of warfare. The opening chapters of the Second World War provide useful historical examples of how this has happened in the past.

Hitler and the Blitzkrieg. The First World War generated the technology for track-laying armored vehicles and more reliable motor vehicles and aircraft. The writings of the British visionary, Sir Basil Henry Liddell Hart, and others soon provided the basis for maneuver warfare doctrine, a concept that could exploit this technology to eliminate defensive superiority, offering a dramatic alternative to the human and material costs of attrition warfare. Thus, by the mid twenties, Britain had made two of the three steps needed to achieve a profound increase in its warfighting potential. Unfortunately, it was unable to make the critical third step—British and Allied military authority, rooted in perceived successes of the Great War, refused to make more than a few feeble-hearted efforts toward investigating the potential of maneuver warfare.[20]

Ironically, vanquished Germany was able to accomplish the key, third step of the process. With its traditional military

authority discredited by defeat, Germany provided fertile grounds for the doctrinal seeds sown by Liddell Hart. German General Henry Wilholm Guderian and others combined Liddell Hart's ideas, their own late World War I doctrine, mechanized forces, close air support, and radio communications to produce the *blitzkrieg*. Most important, they were able to convince Hitler to adopt their new approach to warfare. In the new doctrine, the Fuhrer saw military possibilities paralleling his broader political objectives. He also had the authority to force the *blitzkrieg* concept on a somewhat reluctant German Army.[21] Consequently, Germany became the dominant land power in Europe. Only a fortuitous combination of circumstances bought the Allies sufficient time to adapt to this profound change in the nature of warfare and to defeat the *Wehrmacht*.

Yamamoto and Carrier Warfare. The revolution in naval warfare that occurred in the early stages of the Second World War also followed the three-step model for profound change. Although General Billy Mitchell demonstrated the vulnerability of battleships to air attack in the twenties and most first-class navies developed aircraft carriers, the battleship remained the preeminent weapon at the beginning of the European war.

The carrier task force warfare that decided the fate of the Pacific War was developed only when Admiral Isoroku Yamamoto, a Japanese fleet commander with tremendous authority, began searching for a new doctrine to fight the United States, whose superior naval potential he had long recognized. The success of British naval aviation against the Italians at Taranto in the Mediterranean fired the imagination of several relatively junior but experienced Japanese naval aviators, who developed the concept of a naval strike force based on the aircraft carrier. Yamamoto quickly recognized the applicability of this concept to the war he had to fight. Most significantly, the unique structure of Japanese naval authority gave him—as Commander of the Combined Fleet—the power to implement this concept in the fleet.[22]

Several constants emerge from analysis of these fundamental changes in military affairs.

—First, technology supporting the change has frequently been around for some time, but has not yet been effectively integrated into a military framework that allows exploitation of its full potential.

—Second, the individual who innovatively sees how to apply this technology, and provides the theoretical basis for dramatic change, is rarely in a position to implement his own call for action.

—Third, the dominant military power of the day has been consistently late in adapting to the changed nature of warfare. This last factor may be the most important, because it demonstrates that human resistance to change is particularly strong in institutions that see themselves as successful and dominant. It may well be that institutions seeking leverage against a more powerful adversary are the most willing to assume the risks inherent in adopting a new framework for warfighting.

It is important to recognize exactly what institutions that have first exploited the potential for fundamental change in warfare have actually done. To use a sports analogy, they have not just produced better players or executed existing plays better; rather, they have changed the basic nature of the game, as Knute Rockne did with the innovation of the forward pass. They have not just "product improved" weapons and tactics of the time—they have instead envisioned and implemented a new, more powerful model for warfighting. Because this newer model more effectively harnesses the dynamics of its time, it has enabled the force adopting it to prevail over those who have not.

The key point is that inventors of new warfighting paradigms have rarely created entirely *new things* (weapons, force structure, doctrine). Instead, they have developed a *new approach* to—or understanding of—the way *existing things* relate to one another. As Kuhn would say, they have caused a paradigm shift. The ability to make such dramatic changes in military thinking has often been the hallmark of truly great military leaders. No one put it better than Field Marshal Erwin Rommel, who wrote,

> However praiseworthy it may be to uphold tradition in the field of soldierly ethics, it is to be resisted in the field of military

command. For today it is not only the business of commanders to think up new techniques which will destroy the value of the old: the potentialities of warfare are themselves being continually changed by technical advance. Thus the modern army commander must free himself from routine methods and show a comprehensive grasp of technical matters, for he must be in a position continually to adapt his ideas of warfare to the facts and possibilities of the moment. *If circumstances require it, he must be able to turn the whole structure of his thinking inside out* [emphasis added].[23]

III. WHERE THINGS STAND TODAY

 ECHNOLOGY, ECONOMICS, POLITICS ALL CHANGE—human nature doesn't. And human nature is such that people will only change their old way of doing things when it is absolutely clear that a new way offers something much better, or it is absolutely clear that the old way is not working at all. Consequently, organizations that see themselves as successful are usually highly resistant to change—past success is often the enemy of necessary change. Not surprisingly, then, our Army is in large measure a product of our success in our last truly great military endeavor, World War II. The "Army Concept" cited by Andy Krepinevich—based essentially on operations in Europe from the Normandy Invasion to V-E Day—is still alive and well 46 years later. Victory over the Axis powers, particularly Nazi Germany, is so imbedded in the Army "psyche" that it has consistently "validated" much of our thinking on the nature of mid-intensity conventional warfare.

With the notable exception (perhaps aberration) of the "Pentomic Era," change in the American Army has been evolutionary, traceable in an essentially uninterrupted line back to what defeated the *Wehrmacht*. Our successes in the last big war, in subsequent conventional actions (such as Korea), in deterring Soviet attack during the Cold War, and most recently in the Gulf War have diminished the need—and the desire—to investigate fundamentally different approaches to large-scale conventional warfare. Undeniably, we have greatly improved techniques and equipment that we fight with, but we are still doing pretty much the same things with the same basic organizations. Imagine, if you will, one of the great World War II tactical commanders, such as Wood of the 4th Armored Division, visiting the command post of one of our current units. Other than the use of helicopters and some specific weapon systems, is there anything that he would not immediately understand? Probably not—he could even give us a few pointers.

Our Army enters the nineties with a World War II-based paradigm. And it has been a great paradigm, serving us well in World War II, Korea, the Cold War, and the Gulf, wherever it was appropriate to the circumstances of the conflict. But just how valid will our paradigm be in the future? The age of a warfighting paradigm does not necessarily damage its validity. A paradigm only becomes outdated when some change occurs that destroys its underlying assumptions. For example, the Napoleonic warfighting paradigm was based on the assumption that a spirited assault force could cross the lethal zone of musketry in front of a defensive position before taking unacceptable casualties. The introduction of the rifled musket significantly increased this lethal zone—and the casualties suffered by the assaulting force. Consequently, the rifled musket destroyed one of the basic underlying assumptions of the Napoleonic warfighting paradigm; and the paradigm became invalid.

The problem, of course, was that military leaders continued to believe in the Napoleonic paradigm well into World War I, long after it was obsolete. Military thinking thus diverged from the reality of the battlefield—with catastrophic results. Where do we stand today? Is our 46-year old paradigm still in touch with reality? Have its basic underlying assumptions stood the test of time? These are some of the most important questions facing our Army today, but are we addressing them in any meaningful way? To address these questions, we need to identify the basic assumptions of our current paradigm, then assess their validity in today's warfighting environment.

OUR WORLD WAR II-VINTAGE PARADIGM

The basic foundation for our current mechanized warfare paradigm was laid by a group of post-World War I British visionaries, particularly J.F.C. Fuller and B.H. Liddell Hart. In the twenties, Liddell Hart described his concept for what later came to be called "lightning war" or *blitzkrieg:*

> The secret of success lies partly in the tactical combination of tanks and aircraft, partly in the unexpectedness of the stroke in direction and time, but above all in the 'follow-through'—

> the way that a break-through (the tactical penetration of a front) is exploited by a deep strategic penetration; carried out by armored forces racing on ahead of the main army, and operating *independently*.
>
> The pace of such forces promises a decisively deep penetration *so long as* it can be kept up. It is kept up by a torrent-like process of advance, either swerving round resistance or piercing it at a weakened spot—in which case the tank-torrent contracts in pouring through a narrow breach, and then expands again to its original breadth.
>
> It is the *persistent pace,* coupled with the *variability* of the thrust-point, that paralyses the opponent. For at every stage, after the original break-through, the flexible drive of the armored forces carries simultaneously several *alternative* threats, while the threat that actually develops into a thrust takes place too quickly for the enemy's reserves to reach the spot in time to stiffen the resistance there before it collapses. In effect, both *tactical and strategical surprise* are maintained from start to finish. It is a high-speed 'indirect approach' to the enemy's rear areas—where his vital but vulnerable organs of control and supply are located.[24]

During the opening days of World War II, mechanized warfare broke the bloody defensive stalemate of World War I and restored maneuver to warfare. Simply put, mechanized forces and aircraft, controlled by radio, allowed an attacker to break through or bypass a defensive position at an unexpected time and place and penetrate into the enemy's vulnerable rear areas, rupturing the continuity of his defense before he could react. Tactically and operationally, Liddell Hart's thesis still provides the basic underlying premise of conventional land warfare today.

TODAY'S "ENGINE OF CHANGE"

From the US Army perspective, the premise of maneuver warfare has been really tested in combat only once in 46 years—during the Gulf War. Logically, we should be asking ourselves

some crucial questions: Has some "engine of change," some modern equivalent to the rifled musket that invalidated the Napoleonic paradigm, developed since World War II? What lessons from the Gulf War shed light on the cumulative impact of technology on our current paradigm? The scientific and technological revolution that marked the post-World War II era has clearly been reflected in the military world. In fact, military requirements have often provided the spark for technological progress. The question is: Does the cumulative effect of change in the technological environment over the last 40-some years challenge the validity of a warfighting paradigm based essentially on the final few years of armored-mechanized warfare of the last World War? Has change been evolutionary—progressing within the context of the paradigm—or has it been revolutionary—shattering the basic foundation of the paradigm?

The answer must be *revolutionary change*. Today, vast improvements in two basic battlefield factors—lethality (the ability to kill targets on the battlefield) and visibility (the ability to "see" the battlefield)—have totally outpaced our World War II-vintage vision of warfare. Taken individually, technological changes may appear to be only evolutionary improvements on our World War II experience. However, the *cumulative* effect of technological change makes the World War II mechanized warfare paradigm obsolete and demands a new paradigm. In fact, this new paradigm has been emerging slowly for some time and began to show itself during the Gulf War.

LETHALITY: TODAY'S "MINIE BALL"

The most significant technologically induced change has been the greatly increased lethality of the battlefield. The technological revolution has caused quantum improvements in the ability to kill targets at extended ranges. Consider for a moment the immense improvements in direct and indirect fire systems and other weapons that have occurred since World War II.

Direct Fire. Dramatic improvements in range, accuracy, and lethality of direct-fire weapons make destruction of almost all targets detected within range a real possibility. Direct-fire

engagements have thus become extremely costly to both sides. All World War II direct-fire weapons have been vastly improved, and more than a few new ones have been introduced.

—*Tank Main Gun.* Improvements in muzzle velocity, target acquisition, fire direction, and projectile lethality have improved tank main gun performance as much as the Minie ball improved the lethality of the musket. During World War II, the probability of hitting and killing another tank at 1,600-2,000 meters (about a mile or a mile and a quarter) was approximately 10 percent. Today, that probability approaches 95 percent—improvement by a factor of 10. During the Gulf War, US M1A1 tanks were able to destroy Iraqi tanks at ranges up to 2 kilometers (about a mile and a quarter).[25]

—*Direct-fire Antitank Weapons.* Antitank guided missiles have replaced antitank guns in most armies. With ranges of several kilometers and warheads that can penetrate many centimeters of armor, these missiles threaten all combat vehicles out to acquisition ranges. Recent developments in reactive and high-density armor have limited their effectiveness against the latest-model main battle tanks somewhat, but they remain highly effective against all other targets.

—*Man-portable Antitank Weapons.* Technology also has provided much more effective man-portable antitank weapons. Their development and proliferation have provided a relatively effective antitank capability to all forces, even light infantry.

—*Night Vision Devices.* The advent of both light amplification and thermal devices for target identification and weapon sighting has greatly improved the effectiveness of direct-fire systems under low light conditions. Thermal devices have even stripped away the masking effects of smoke, fog, and haze. With laser indicators, even rifle fire can be as accurate at night as in full daylight.

Indirect Fire. Dramatic improvements in indirect-fire capabilities also have contributed to the greatly increased lethality of the modern battlefield. Historically, artillery has been the big killer on the battlefield. The march of technology may

make this even truer today. Modern improvements in indirect fire technology include:

—*Precision-guided Munitions.* Precision-guided munitions make it possible to destroy even mobile-point targets almost as soon as they are detected. Laser, infrared, radar, or fiber optical cable guidance systems in smaller and smaller packages have totally revolutionized the probability of hitting a target at greatly extended ranges.

—*Area Coverage Sub-munitions.* Introduction of area coverage sub-munitions has greatly increased the ability to saturate a target area with highly lethal indirect fires. The fielding of "smart" sub-munitions that seek targets as they descend will increase the lethality of indirect-fire systems even further, making it possible to destroy massed forces with single-battery salvoes.

—*Tactical Ballistic Missiles.* Modern tactical ballistic missiles combine the range of heavy missiles with precision guidance and area coverage sub-munitions to destroy point or area targets up to 70 km (about 43 miles) away. As shown by the performance of *PATRIOT* missiles in the Gulf War, they can be countered to a degree by antimissile missiles.

—*Automated Fire Direction.* The ability to "maneuver" and mass fires without moving firing units is unique to indirect-fire systems. The application of automation to fire direction has literally made it possible to quickly mass accurate, conventional fires from all indirect-fire systems within range on any given target.

—*Target Acquisition.* Fire-finder systems—radars that track incoming artillery rounds and rockets, combined with computers that calculate firing points of incoming rounds—make it possible to locate enemy indirect-fire weapons after they have fired only one or two rounds.

Antiaircraft Systems. Antiaircraft systems at all echelons were some of the first weapon systems to benefit from the post-World War II technological revolution. Today, anything flying more than a few feet above ground is highly vulnerable to extremely effective antiaircraft guided missile fire.

During the Gulf War, our tactics and countermeasures were so successful in defeating Iraqi antiaircraft missiles that we may

underestimate the effectiveness of these systems. The following account describing the Israeli experience on the Golan Heights during the 1973 Arab-Israeli Yom Kippur War shows how effective these systems can be when not properly countered:

> In the area of Juhader, Oded, commander of the 3rd Battalion, asked for air support with first light. As the sun rose, four Israeli Skyhawks swooped in to bomb the Syrians, but as they approached their target the tell-tale signs of surface-to-air missiles were seen. All four planes exploded in the air in full view of the hard-pressed troops of the battalion. Undeterred, a second flight of four planes flew in. Two exploded.[26]

Air Support. The ability to destroy point targets such as bridges from the air has improved incredibly since World War II. During that war, thousands of bombers were sometimes directed against a single critical point target to ensure its destruction. During Vietnam, more than 700 fighter-bomber sorties were flown against an important bridge near Hanoi before it was finally destroyed. During the Gulf War, single F-117A "Stealth" fighters were used to attack bridges, with almost 100 percent assured destruction.

Helicopters. The introduction of large numbers of helicopters has revolutionized the concept of mobility. Infantry, light artillery, even light armor can now be freed of the "tyranny of terrain" and moved almost at will around the battlefield, even at night. Attack helicopters combine this great mobility with firepower able to destroy the heaviest tanks, providing commanders with one of the most flexible and lethal weapons ever known.

CONSEQUENCES OF THE NEW LETHALITY

When both sides follow World War II-based warfighting paradigms, this technologically created, highly lethal environment can lead to very rapid attrition on both sides. The Arab-Israeli Yom Kippur War of 1973 is a good example of what can happen—combined Arab and Israeli tank losses exceeded the

total number of tanks then deployed in NATO.[27] Chaim Herzog, writing in *The War of Atonement*, describes the lethality of the battle of the "Chinese Farm" near the Suez Canal:

> In all directions the desert was covered with a vast fleet of burning and smoking tanks, vehicles, guns, transporters; dead infantry lay everywhere. It seemed as if there was not a single item of military equipment which had escaped destruction: there were command caravans, mobile workshops, huge transporters carrying SAM 2 missiles, mobile kitchens. The remnants of the Israeli forces were there too. '...In a short stretch of a few thousand yards stood twenty-four totally burnt-out Israeli Patton tanks. Few of their crews could have survived. About a hundred Egyptian tanks littered the battle area.'[28]

In the face of such heavy losses and high consumption, logistical support—hampered by difficulties stemming from inadequate prewar stocks of ammunition, spares, and replacement equipment and vulnerable to the effects of increased lethality—faced virtually insurmountable challenges. Victory, often Pyrrhic, can only fall to the side that doesn't run out of forces. The Iran-Iraq War, so tremendously costly that neither side "won" at an "affordable" cost, provides a dramatic example of how devastating even a relatively modest application of modern technology can be.

But the Gulf War was different—only the Iraqis suffered the devastating effects of modern lethality, despite prewar predictions of much heavier US and allied casualties. Why this one-sided destruction happened undoubtedly will be a major subject of debate as we sift through the lessons of the war over the next few years. However, a previously unrecognized factor clearly gave the United States and its allies an unaccounted for but highly welcome advantage. I would argue that this factor was a superior understanding of the nature of modern warfare, an emerging new warfighting paradigm. (Section VI develops the argument for this thesis.)

NEW VISIBILITY: DISPELLING THE "FOG OF WAR"

Some of the more recent dramatic improvements in battlefield capabilities have to do with the commander's ability to "see" the battlefield (to know friendly and enemy locations and activities) and to command his own forces—to grasp the battle. Cumulatively, these capabilities are normally grouped under the heading of command, control, communications, and intelligence (C^3I).

Grasping the Battle. Collectively, C^3I capabilities provide commanders at all levels their ability to manage the battle. To manage the battle effectively, commanders must be able to collect, analyze, disseminate, and act on battlefield information collected from a variety of sources, including subordinate units, intelligence units, and higher headquarters. Usually, it all pours into a headquarters or command post via multiple communications means and is analyzed by the unit's staff to develop a comprehensive view of the battle. The most critical information is passed directly to the commander. After analysis, "refined" information is disseminated to subordinate and higher headquarters for their information or action. Commanders act on information by transmitting orders to subordinate units to engage an enemy force, change locations, and so forth.

None of these functions is new, of course. Commanders since Alexander the Great (or earlier) have needed these capabilities to direct battles—otherwise, battles become disorganized brawls among individual combatants (which sometimes happens anyway!). The great commanders have long recognized that victory depended on their ability to collect, analyze, disseminate, and act on battlefield information. Wellington and other successful Napoleonic-era generals led from the front—not necessarily from bravado but rather because the front was where they could best collect, analyze, disseminate, and act on information. Limited communications means—couriers—kept them from commanding over any distance. Consequently, their greatest talent was the ability to sense decisive points in the battle and arrive there in time to influence the action. Successful modern commanders also have recognized the importance of grasping the battle—keeping their own eyes and hands on key events. Erwin

Rommel wrote of his actions during the turning point of the first battle for Tobruk,

> As the situation was rather confused I spent next day at the front again. It is of the utmost importance to the commander to have a good knowledge of the battlefield and of his own and his enemy's positions on the ground. It is often not a question of which of the opposing commanders is the higher qualified mentally, or which has the greater experience, but which of them has the better grasp of the battlefield.[29]

Thus, neither the functions of C^3I nor its importance are new to warfare. What is new is the ability of technology to vastly enhance the performance of these functions.

Command, Control, and Communications. Application of technology to the absolutely critical battlefield function of C^3 has been much neglected until the last 10 years or so. Consequently, most units still perform C^3 by posting acetate map overlays with reports taken over 20-year-old radios. However, the technology is currently available to revolutionize how we do our C^3 business. With systems currently being fielded, the location (to 10-digit grid coordinates or within 10 meters (a little over 30 feet)) and status of every element can be reported automatically to a commander, wherever he may be. Most importantly, *units* also know where *they* are all the time, essentially eliminating the "lost lieutenant" factor of the fog of war. Consequently, a commander can reliably know the complete disposition of his force in absolute real time.

The advantage of similar navigational systems, such as the Global Positioning System (GPS), was clearly evident during the Gulf War. Using small, paperback-book-sized receivers that triangulated signals from the GPS satellite constellation, thousands of vehicles and small units navigated across hundreds of miles of trackless desert without getting lost. Reliable communications are also essential for a force to react rapidly to changing battlefield events. Here, too, technology has provided a quantum leap in capability. For example, satellite communications

systems small enough to fit in a backpack can provide absolutely reliable communications across entire continents.

Intelligence. During World War II, intelligence often depended on delayed reports from sometimes confused and excited front-line units or on hours-old (or days-old) aerial photographs, radio intercepts, or agent reports. The commander's ability to see the enemy side of the battlefield was thus rather limited.

Today's intelligence-gathering capability bears about as much resemblance to this antiquated system as a B-1 bomber does to a biplane. Sensor systems, such as ground and airborne radars, forward-looking infrared, long-range electro-optics, and satellites, can peer over distance and through night, smoke, fog, clouds, and camouflage to lay bare the smallest details of an enemy's disposition. Further, technology makes it possible to analyze this information and disseminate it to division and brigade-level commanders almost instantaneously. For all intents and purposes, commanders can get a technological "God's eye" view of the entire battlefield. It should be noted, however, that while this capability exists, it has not yet been fielded to its full potential in any army.

SPACE

As noted above, space-based systems have contributed enormously to the revolutionary improvement in C^3I. Their battlefield contribution will increase even further as their capabilities are refined and their support is pushed down to the lowest tactical users—as happened with the satellite-supported, hand-held navigational devices used during the Gulf War. However, space operations have yet to make their full impact on land combat. To date, we are still in the "biplane" era of space operations. Early aircraft were first used during World War I to revolutionize reconnaissance and other existing C^3I functions. Today's space systems have done the same—supporting operations in land, sea, and air media.

However, it wasn't long before aircraft truly came into their own, acting as a revolutionary form of fire support for ground operations and conducting combat operations of their own to dominate the air medium. Spacecraft may well follow this same path. The implications of space combat are beyond the scope of this paper; however, we must recognize that the capabilities to conduct space combat operations to achieve space superiority are technically possible. Like air operations, as space operations grow increasingly important to warfare, control of the space medium will become critical.

Similarly, space may become increasingly important to fire support. Today, it is probably technically feasible to use space-based systems to provide terminal guidance for smart munitions fired from land or air. In the future, weapons might actually be fired from space-based systems themselves. The bottom line is that space operations are *already crucial* to modern warfare—and *will increase in importance* in the future. Therefore, we must look at the *full* implication of extending warfare to this fourth medium—we cannot restrict our vision to the impact of space operations on land, sea, and air alone.

IMPACT ON THE WORLD WAR II WARFIGHTING PARADIGM

To date, we have incorporated all this technological progress within our current paradigm—innovation has been met by counter-innovation. For example, increased lethality has been dealt with in part by new and better armor (reactive and depleted uranium armor) in the classic offensive vs. defensive weapon competition that dates back to the Middle Ages, when armor was made heavier to cope with crossbows and early firearms. We have improved tactics and countertactics. We have spent immeasurable time and treasure simultaneously attempting to obtain the benefits of new technologies for ourselves while negating their effects in the hands of our adversaries. What we have *not* done is ask ourselves if all this change has done irreparable damage to our basic warfighting paradigm.

Returning to the fundamental assumptions laid down by Liddell Hart—can we still achieve a breakthrough and follow it up with a decisive penetration that disrupts the continuity of a defense? Can we do it at an affordable cost? Let's look at the elements.

Surprise. As Liddell Hart wrote, "unexpectedness of the stroke in direction and time" is one of the key ingredients in achieving a successful breakthrough.[30] But what has the new visibility on the battlefield done here? Is it still possible to achieve the level of surprise that the *Wehrmacht* achieved in the Ardennes in 1940 and again in 1944 or that the Egyptians achieved along the Suez Canal during the Yom Kippur War in 1973? The answer is both yes and no.

Yes—in the sense that it is still possible to achieve surprise even when the enemy knows virtually your entire disposition, because it is almost impossible (given good operational security) for him to know your *intent*. The Israelis found this out the hard way in 1973—so did the Kuwaitis in 1990.

In 1973, the Israelis knew the full disposition of the Egyptian Army as it moved into assault positions along the Suez. However, the Egyptians had moved up to the Canal many times before; and the Israelis dismissed this movement as just another exercise intended to cause them to mobilize their reserves—an economically expensive proposition. In 1990, the United States provided Kuwaiti leaders with full details of Saddam Hussein's force deployments along the Iraq-Kuwait border. However, the Kuwaitis dismissed the Iraqi deployments as only an attempt to pressure them into compromising on oil pricing. In both cases, the defenders had full details of the attackers' deployments, but they didn't know the attackers' intent.

No—in the sense that it is now very difficult to mass sufficient forces to achieve a breakthrough without the enemy knowing about it. Current US Army tactics call for at least a three-to-one force ratio to achieve a penetration. Even at the lowest tactical levels, this ratio requires massing a battalion (about three companies) with more than 100 armored vehicles on about a kilometer (less than 1 mile) front. With today's sensors, it should be almost impossible to achieve such massing without being

discovered, even with the best tactics executed under the most advantageous conditions.

Achieving a Breakthrough. Assuming surprise is somehow achieved, is it possible to break through a defense at reasonable cost? Yes—but only under favorable circumstances. The objective in a breakthrough is for the exposed attacker to pierce the positions of a defender fighting from behind protection of some kind before the attacker suffers unacceptable casualties—a universal problem for all warfighting paradigms, probably of all ages. Because of the increased range and effectiveness of the defenders' weapons, elaborate tactics and techniques have evolved to solve this increasingly difficult problem.

First, an attacker will attempt to find a little-defended route around or through the position. Second, he will attempt to degrade the effectiveness of the enemy fire by using smoke or other obscurants and jamming his radio frequencies to keep the enemy from moving forces or adjusting artillery fire. Third, he will use supporting artillery or air to destroy or suppress enemy fire. Fourth, he will attack in echelons so that even if the attacking echelon has spent its strength in finding or creating a weak point, following echelons will still retain enough strength and organization to exploit the penetration.

Unfortunately, increased lethality and visibility of the modern battlefield make an attacker's success increasingly uncertain. To begin with, finding a weakly defended route through even a hastily prepared position is increasingly difficult. Extended ranges of primary weapons have greatly increased the area they can cover, making it possible to defend extended areas effectively with fewer, well-sited weapons. Second, the proliferation of lighter antitank systems has greatly increased the density of effective antitank weapons on the battlefield.

The Israelis discovered this enhanced defensive capability the hard way along the Suez in 1973, when they counterattacked the crossing Egyptian infantry with armor. In previous conflicts, they had been able to penetrate positions defended by Arab infantry and then outmaneuver the Arab antitank reserve. In 1973, however, the Egyptians fielded the effective hand-held antitank weapon, the Rocket-propelled Grenade (RPG)-7, down

to squad level and the *Sagger* antitank guided missile down to company level. Consequently, the Israelis faced a uniformly dense antitank defense that initially crippled their armor-pure attacks. They were finally able to overcome this defense with combined arms tactics, attacking only with artillery and infantry support.[31]

In attempting a breakthrough, the attacker also is subject to the increased lethality of the defenders' indirect-fire weapons, which now can be rapidly massed against any target within range. As enhanced sensors have increased the probability of detection at extended ranges, the attacker can almost count on being under effective artillery fire out to the effective ranges of the defender's indirect-fire weapons. Armored forces attempting a breakthrough depend heavily on air support—either from attack helicopters or fixed-wing aircraft—for the highly responsive and flexible firepower needed to blast through enemy defensive positions or to contain enemy counterattacks. However, the increased lethality of the flight envelope in which this air support has to operate can make effective close air support increasingly costly and difficult.

Introduction of the *STINGER* man-portable ground-to-air missile in Afghanistan bears out this difficulty. *STINGER* hit rates were reported as 79 percent—so high that they rapidly tipped the air balance by forcing Soviet pilots to attack at such high speeds or altitudes that their ordnance delivery became very ineffective. According to Anthony Cordesman,

> its success... demonstrates how even a relatively simple weapon system can have a major impact on combat and particularly on air and helicopter operations.[32]

True—there *are* tactical counters to the enhanced lethality of the defense. Proper use of smoke and supporting artillery to degrade the effectiveness of antitank and antiaircraft fires, use of helicopter-inserted light infantry to take positions from the rear, proper combined arms tactics to breach obstacles—all *can* be carefully orchestrated to pull off a successful breakthrough attack. The problem is that the *probability* of making everything happen that must happen for a successful attack is becoming

increasingly small. The smallest failure—such as the engineer's inability to breach an obstacle quickly—can all too easily leave the attacking force stopped and exposed to the full lethality of a defender's weapons for critical minutes. Only minutes' exposure to such lethal fire is needed to destroy an assaulting force.

Until the Gulf War, the closest our Army had come to experiencing the consequences of increased battlefield lethality and visibility was at our fully instrumented training sites, such as the National Training Center at Fort Irwin, California, and the Combined Maneuver Training Center in Germany. At these installations, all participants—vehicles, personnel, even most helicopters—are equipped with laser systems that fully replicate the effects of direct-fire weapons. Extensive instrumentation and control measures also allow moderately realistic representation of indirect fire effects. Run by a dedicated cadre with full-time forces representing the "enemy," these training areas are highly effective in simulating the modern battlefield, under conditions in which both sides are roughly equal in terms of training, leadership, and motivation.

While the intent of such realism is training, not testing, it is possible to draw some general conclusions from unit performance at these centers. And the conclusions are pretty disturbing. Most attempts at breakthrough attacks are not successful. Even those that *are* successful often result in a combat-ineffective assaulting force. And these forces make up perhaps the best Army we've ever produced—one that annihilated the Iraqis in 100 hours of combat. We blame failure on leadership or training, but if even these high-caliber units have great difficulty executing a breakthrough attack against an evenly matched force most of the time, maybe we need to ask if we're not assigning them an impossible task—like Pickett faced at Gettysburg.

Achieving a Penetration. Even if a breakthrough is achieved, following it up with an effective penetration also has become increasingly difficult—against a cohesive, well-led enemy. Liddell Hart's thesis depends on the penetrating forces' ability to paralyze the enemy by presenting it simultaneously with multiple potential threats, making it impossible to decide where to commit reserves. However, the visibility of today's

battlefield makes it hard to confuse the enemy. Once a penetrating force is committed to a specific course of action, the reduction of the traditional "fog of war" makes it difficult to conceal this course of action from the enemy commander for a decisive length of time.

Further, the enemy commander now has at hand a highly lethal, flexible, and uniquely maneuverable reserve asset to commit almost instantly against a penetration—the attack helicopter. With automated and centralized artillery fire direction, he can also mass indirect fire assets against a penetration very quickly. Together, indirect fire and attack helicopters—and even artillery and air-delivered scatterable mines—can stall a penetration until an armored reserve force can maneuver against it.

Impact on the Defense. Of course, increased battlefield lethality and visibility also can greatly enhance the effectiveness of the offense. Proper use of sensors and reconnaissance can lay bare the smallest details of a defense. Units occupying fixed-defense positions are then highly vulnerable to the effects of massed artillery, and precision-guided munitions (air and artillery delivered) can destroy key targets almost at will. Attack helicopters and fixed-wing close air support can also make it very difficult to reposition a reserve force for a counterattack. Thus, a defending force is also vulnerable to the greatly increased lethality of the modern battlefield—as the Iraqis learned in the Gulf.

SUMMING UP: DEMISE OF THE CURRENT PARADIGM

The point is *not* that it is now impossible to conduct offensive or defensive operations according to the tenets of our current World War II-vintage paradigm, but that it is increasingly *difficult to do so in the same old ways and at an affordable cost.* Just as the American Civil War was won with an obsolete paradigm, it is still possible to "win" today with our current paradigm, but at what price victory?

In 1914, the Great Powers disregarded lessons learned from the Russo-Japanese war of 1904-05, in which both sides employed machine guns, quick-firing artillery, barbed wire, and

other modern weapons—and suffered almost a quarter-of-a-million casualties each. This war was observed by many highly professional observers from the Great Powers (Captain John J. Pershing, US Army, among them). But it was fought in an undeveloped area under conditions that the Great Powers thought were so different from Europe that they dismissed its lessons.[33] Perhaps cultural bias was also a factor.

Today, we disregard at our peril the lessons of the three most recent conventional land conflicts—the Yom Kippur War of 1973, the Iran-Iraq War, and the Gulf War. In the Persian Gulf, we saw the devastating effects of new battlefield lethality and visibility on an Iraqi force that was unprepared to cope with them—we saw the high cost the Iraqis paid for using new weapons in old ways. These three wars cannot be dismissed as secondary conflicts against second-rank combatants—they clearly portend the future for followers of the current warfighting paradigm.

Modern war hasn't become so much more destructive than the past—World War II battles certainly rivaled more recent conflicts in their destructiveness. The difference between the present and the past is that the destruction has now become immensely more *compressed* in time and *extended* in space than it ever was before—and the World War II-vintage warfighting paradigm offers no way out. It is now doubtful that any nation fighting according to the current paradigm against even a roughly comparable, let alone superior, opponent can accomplish its war aims at reasonable cost—a cost that the nation is willing to pay for any interest short of national survival. However, key elements that have historically preceded the advent of a new warfighting paradigm, one that better accommodates our present technological environment, are either already in place or are rapidly evolving.

IV. TOWARD A NEW PARADIGM

IF TECHNOLOGICALLY GENERATED INCREASES in battlefield lethality and visibility have shattered the current "truths" of modern warfare, what then are the new "truths"? Is maneuver warfare, as described by Liddell Hart, obsolete or is it still a useful basis for military operations?

THE NEW PARADIGM: PRECISION WARFARE

The key to understanding the new "truths" of modern warfare lies in grasping the combined impact of the new battlefield lethality and battlefield visibility. Increases in both of these battlefield factors greatly affect the "precision" with which we can fight. Increased lethality allows targets to be engaged much more precisely than before and at extended ranges. Increased battlefield "visibility"—provided by enhanced C^3I—allows us to grasp the battle much more precisely and quickly. Thus, technology has made warfare much more certain and precise than was ever thought possible.

The synergism between the new lethality and the new visibility also has greatly increased the *pace* of warfare—enhanced visibility makes it possible to obtain and decide on information much more rapidly, while enhanced lethality makes it possible to react to that information even more quickly. Thus, the speed of the "identify, decide, act" cycle is greatly increased. Consequently, warfare can be more deadly than ever before. If we can fully understand not only the dangers but, more importantly, the advantages and possibilities of the new battlefield lethality and visibility, we will achieve a much more effective understanding of the true nature of modern warfare. We will, in effect, create a new, more useful warfighting paradigm based on the thesis that:

> in modern precision warfare, the ability to collect, analyze, disseminate, and act on battlefield information becomes the dominant factor on the battlefield, displacing shock action and massive firepower from their position of preeminence.

How, then, should we fight? The answer is *exploit the vastly improved ability to "see" the battle, to analyze and communicate information, and to act on that information to—*

—Rapidly identify the point of decision—that point where the battle will be lost or won—and other critical points of battlefield leverage that require focusing of effort.

—Avoid decisive engagement unless absolutely necessary. With today's highly lethal weapons, decisive engagement—an engagement from which it is impossible to disengage without endangering the engaged force—has become such a "duel to the death" that even the winner suffers unacceptable losses.

—Mass only briefly to destroy vulnerable, key targets. By keeping our forces dispersed until the decisive moment, they remain harder to detect and less vulnerable to area-effect weapons. Dispersion also makes it much more difficult for an enemy to determine our intentions.

—Employ long-range precise fires where possible, particularly to suppress defenses. Long-range weapon systems, particularly indirect-fire weapons using precision munitions, are much less vulnerable to counterfire than weapons that must engage within direct fire ranges.

If we can do this, we can avoid much of the lethality of modern weaponry while subjecting the enemy to its full effects.

PRECISION WARFARE OPERATIONS

The fundamental question is: does precision warfare make maneuver warfare obsolete? The answer is absolutely not—the basic concept of maneuver warfare is still very valid; *however,* the way we go about achieving a breakthrough and penetration should be radically different.

Since at least the American Civil War, concepts of warfare have fallen into two general categories: attrition warfare; and

maneuver warfare (often referred to as annihilation). In *attrition warfare,* the objective has been to win by "grinding" the enemy down, inflicting more casualties than the enemy can afford to suffer. In *maneuver warfare,* the objective has been to maneuver to place the enemy at such a disadvantage that he must surrender or be destroyed. By and large, maneuver warfare, much cheaper and more glamorous, has been much preferred over attrition. The problem with maneuver warfare lies in the "how to." Recall that the World War I generals almost always sought to achieve the hallowed breakthrough that would lead to open-field maneuver warfare.

Unfortunately, technology outpaced their thinking on how to achieve such a breakthrough. Our problem today is how to achieve a breakthrough and subsequent penetration in light of the new battlefield realities. And it is here that the precision warfare paradigm is most valuable. Forces that both understand and exploit the advantages of the new paradigm *can* achieve breakthroughs and penetrations on the modern battlefield—at reasonable cost.

Offensive Operations. The following example shows how offensive operations might be conducted under the precision warfare paradigm. Suppose that a commander understands the paradigm and has a force organized, equipped, and trained to fight it. How would he conduct offensive operations? His force would have the following capabilities:

—It knows with virtually 100 percent certainty where its elements are at all times. It knows enemy dispositions down to individual combat system level with a high degree of certainty.

—It has the analytical capability to digest the vast volume of battlefield information it receives and to present it in useful form to commanders at all levels in near real time.

—A high degree of tactical *and* operational-level mobility gives it the agility to react very rapidly to changing battlefield conditions.

—It has highly reliable voice and data communications with all its elements at all times.

—It can destroy almost any target within range of its organic or supporting weapons.

—Low ammunition consumption and organic combat service support allow it to operate for extended periods without relying on external support and secure lines of communication.

Assume that the commander faces either a present-day Soviet-style defense—multiple, layered echelons of strongpoints spread out linearly, supported by heavy concentrations of artillery and backed by large armored counterattack forces—or a more precision warfare-oriented mobile defense with units dispersed and concealed in preparation for coordinated counterattacks.

Recognizing that battlefield information is the key to success, the commander would open the engagement by using every information-gathering asset available at the longest ranges possible. Enemy C^3I would be a priority target for engagement with precision munitions at extended ranges. We do much of this today in the form of intelligence preparation of the battlefield. However, precision warfare requires much greater detail—down to individual enemy tanks and vehicles—provided in near real time to the lowest level tactical commanders. The main purpose of this intensive intelligence gathering would be to identify the center of gravity of the enemy defense (key terrain, a force or headquarters whose possession or destruction will unhinge the entire enemy defense) and the best avenues of approach (multiple avenues are much preferred to avoid massing) leading to the center of gravity. Enemy forces with the ability to react to friendly attacks along these avenues of approach would be identified in the greatest possible detail.

As friendly maneuver forces move along the avenues of approach, enemy forces in position to detect or engage them are attacked with long-range-precision indirect fires just before contact is made. Thus, supporting fires effectively clear a corridor directly in front of the attacking maneuver forces just in time for them to pass through. Predesignated engagement areas (essentially "ambush" zones where an enemy is most vulnerable) are set to destroy counterattacking enemy forces with precision munitions as they move against the attacking maneuver force.

Ideally, the attacking force should not have to become involved in a direct-fire engagement until it has broken through the defense and attacks the center of gravity. For this attack, the force masses briefly to achieve an immediately decisive force

ratio, destroys the center of gravity, and then disperses to move along avenues of approach leading to the next objectives. Several characteristics of a precision warfare offense distinguish it from our current approach:

—Maneuver forces are not massed before the attack. The attacking force operates in small units dispersed along as many avenues of approach as possible. It proceeds directly from the march column to the attack without stopping to deploy, and deploys only when the commander of an element knows he is about to become involved in an unavoidable direct fire engagement. The attack force masses only long enough to destroy key targets that cannot be bypassed or destroyed by long-range precision fires.

—Indirect fires also are not massed. Only enemy C^3I assets and forces that directly threaten the attacking maneuver force are engaged with precision munitions. Thus, only a small number of rounds are fired, but they neutralize key targets. Massive fires that would give away friendly intentions and reveal the locations of indirect-fire systems are avoided.

This precision-warfare approach to penetrating a defense is very similar to the way in which we get helicopter formations over a fixed defense today. First, we developed detailed intelligence that pinpoints the enemy's air defense assets. We then identify a "least risk" route that avoids as much of his air defense as possible. Finally, we fire artillery to suppress those air defenses the helicopter formation must cross just before the helicopters reach them. The problem we face with these operations today is that they require a lot of time and effort to plan. A high-level staff (usually division, sometimes brigade) must put in an inordinate amount of work to develop and collate the necessary intelligence and coordinate all the routes and fires. Forces prepared to fight precision warfare should be able to do all of this routinely with much of the effort assisted by automation.

Defensive Operations. A precision-warfare defense would not look radically different from the offense. In fact, the defending commander would depend on limited offensive operations to keep the attacker from developing a coordinated, integrated offensive, similar to conducting mobile defenses today—the difference again

lies in the "how to." The defending commander would keep his forces dispersed in small, mobile elements to avoid presenting a fixed, mass target and to prevent the enemy from determining friendly intentions. Occupation of fixed defensive positions, possibly leading to decisive engagement against a superior force, would be avoided. As in the offense, battlefield information is the key to success. The commander would open the engagement by using every information-gathering asset available at the longest ranges possible. His priority task would be to identify the center of gravity of the enemy's offensive operation, probably a major element of the enemy's C^3I capability.

The defending commander's intent would be to blind and paralyze the attacker, then destroy the attacker's center of gravity. To achieve this destruction, the defender would first predict when and where the attacker's center of gravity would be most vulnerable to attack. Demolitions or long-range precision fires and air- or artillery-delivered scatterable mines might create rapid obstacles designed to break the continuity of the enemy attack and expose his center of gravity. To attack the center of gravity, the defender would first neutralize enemy C^3I with precision munitions fired from extended ranges or electronic warfare to blind and paralyze the enemy, preventing coordinated enemy reaction to the defender's attack. Friendly forces then would use long-range precision fires to cut maneuver corridors leading to the enemy center of gravity. Maneuver elements would use these corridors to mass briefly, destroy the center of gravity, then retire.

Throughout the defense, the counter-C^3I battle focused on denying battlefield visibility to the enemy would be critical to success. An attacking commander who cannot see the battle and cannot control his forces will have little chance of success against an enemy who can do both, regardless of the relative sizes of the two forces.

PRECISION WARFARE TODAY

It may be tempting to dismiss precision warfare as some analytical construct, suited only for some twenty-first century "Buck

Rogers" army. Nothing is farther from the truth. In fact, US Army forces conducted what I would now term precision warfare operations in the early eighties.

During development of the high-technology light division (HTLD) at Fort Lewis, Washington, the 9th Infantry Division—the "test bed" for the HTLD—actually trained, organized, and equipped forces capable of fighting precision warfare. The following vignette—one of many available—is illustrative of HTLD operations.

During an exercise at Fort Bliss, Texas, in the spring of 1985, a battalion from the 9th Infantry conducted a night attack against an opposing force (OPFOR) armored cavalry squadron and an airborne infantry battalion. The attack took place in a highly dissected sand dune area where navigation is extremely difficult even in daylight. The battalion from the 9th was organized as a combined arms battalion with two motorized infantry companies mounted in 1 1/4-ton pickup trucks and one company of Improved Tube-Launched, Optically-Tracked, Wire-Guided (TOW) Vehicles (ITVs—M-113 armored personnel carriers mounting an erectable TOW missile launcher). It also had a platoon of ground-launched *HELLFIRE* missiles (*HELLFIRE* missiles mounted in the beds of pickup trucks). The entire battalion was equipped with the Position Locating and Reporting System (PLRS) down to platoon level. PLRS electronically calculated the exact location (10-digit grid coordinates) for each system and automatically displayed these locations on a base station at battalion, brigade, and division command posts. Thus, each unit knew its own location precisely, as did its parent headquarters. The unit also was equipped with night vision goggles and digital transmission devices. The battalion opened the night attack by sending its scout platoon forward to identify a possible seam between the two defending OPFOR battalions. Operating on precise intelligence provided in part by long-range electro-optic observation posts (capable not only of seeing tanks but also reading their bumper numbers at well over 10 kilometers (6 miles)), the scouts navigated by PLRS and quickly identified a seam several hundred meters wide through the jumble of sand dunes. The scouts passed the coordinates of this seam back to

the battalion, using digital transmission devices. Guided by PLRS, the battalion then infiltrated by company columns along the seam. The 9th Infantry battalion was 10 kilometers (6 miles) to the rear of the OPFOR battalions when it was finally detected. The OPFOR regiment quickly counterattacked with another armored cavalry squadron, but the battalion trapped this counterattack force in an engagement area and destroyed it at long range with ground-launched *HELLFIRE* missiles. The battalion then proceeded to destroy the OPFOR regimental trains. The brigade and division command posts watched the entire operation unfold on PLRS displays and forward-looking infrared downlinks from a surrogate unmanned aerial vehicle. Note the date well—this exercise took place in 1985.

IMPLICATIONS OF THE PRECISION WARFARE PARADIGM

Clearly, the potential to adopt the precision-warfare paradigm is here today. *If* precision warfare becomes the dominant paradigm in our army, it has tremendous implications for how we should fight. Some of the most significant are discussed below.

Decreased Battlefield Losses. Obviously, if we have much better information—and the ability to analyze and disseminate it—we can avoid being surprised and other typical battlefield disasters that normally lead to heavy losses. But precision warfare allows us to avoid unnecessary casualties in other ways. First, we should be able to determine *when* it is absolutely necessary to accept decisive engagement with *what* specific enemy forces, avoiding unnecessary and highly lethal direct-fire engagements. Second, using long-range precision fires to destroy key targets is much safer than using direct fire. Finally, because we are engaging only those targets that we must engage to accomplish our purposes, we are reducing the total amount of combat our forces are exposed to.

This latter point is most significant, because it minimizes both friendly *and enemy* casualties. For example, if we are attacking a Soviet-style tank battalion with 34 tanks, it isn't necessary to engage every tank. If we destroy the battalion's command and

control, its individual tanks will sit there and engage only those targets they can see once they have executed their last order. If we know exactly where those tanks are, we can either avoid them or destroy only those that can threaten our scheme of maneuver.

We do this already. Every gunner knows to shoot the vehicles with the most radio antennas (that is, the command-and-control vehicles) first. But with our enhanced ability to see the battlefield and hit targets precisely at long ranges, we can deliberately track the enemy's command-and-control elements and destroy them precisely at the most advantageous time.

Increased Force Potential. One of the determining factors in a force's fighting potential is its ability to get the right forces fighting at the right place at the right time. Many battles have been won by having a unit, often very small, take decisive action at a decisive point in the battle. Case in point—the US Army engineer squads that destroyed key bridges just in front of Task Force Piepper during the Battle of the Bulge. Training, discipline, planning—but mostly luck—put these engineers in front of the German spearheads, where they did the most good. Today, we don't have to depend on luck. Our greatly enhanced C^3I allows us to employ all our elements of combat power at the most useful place and time.

Enhanced battlefield visibility has further implications. Today, a commander deals with uncertainty by dedicating (often withholding) forces to deal with unforeseen circumstances. For example, he maintains a reserve in the attack to exploit the breakthrough of attacking elements. Since he usually doesn't know exactly when and where the breakthrough will occur, he positions the reserve where it can exploit any of several possible breakthroughs. Of necessity, this positioning may not be optimal for any one specific breakthrough, and the reserve may be slower than desirable in exploiting. The same is true of defense. A reserve is positioned to counterattack any of several possible enemy breakthroughs. Further, forces are often spread out linearly to cover every possible enemy avenue of approach. Consequently, they may end up covering avenues the enemy never uses and staying out of the fight entirely. The list goes on and on. We dedicate forces to cover our flanks during movement, to

screen areas the enemy might move into and threaten us, and so on. Today's commander always faces a major dilemma: He can concentrate his forces at what he *thinks* will be the decisive point of the battle and risk being wrong; or he can disperse his forces to cover more possible decision points—and risk having insufficient force at the decisive place and time.

If he understands the precision-warfare paradigm, the commander can *afford* to take much greater risks. With his much better understanding of what is happening on the battlefield, he stands a much greater chance of picking the right decision point. Even if he's wrong, enhanced C^3I will allow him to know that he's wrong early on and adjust forces accordingly. Thus, a force can concentrate its efforts on the decisive points in the battle without dispersing its effort to cover a multitude of possibilities.

Today's commander has the choice between a shotgun and a rifle. The shotgun has a much greater chance of hitting the target but its small pellets may not have sufficient power to destroy it. The rifle will surely kill the target but stands a much greater chance of missing. *With precision warfare, the commander has a rifle that can't miss.*

Reduced Force Structure. This increased force potential means that a commander can accomplish much more with fewer forces, especially against a force that is not prepared for precision warfare. However, the ability to apply forces much more precisely on the battlefield also has significant structural implications. For example, the number of indirect-fire support elements required to provide a given level of support can be reduced considerably. Precision munitions and enhanced C^3I greatly increase the probability of hitting a target with a given round. Simply put, if the probability of a hit is increased by a factor of, say, two, then the number of guns firing can be reduced by half without affecting the effectiveness of the support. However, if we also reduce the *number* of targets that have to be engaged by shooting only at what must be destroyed, we can further reduce the number of guns required.

Combat service support (CSS) for the lower number of guns also decreases proportionally. If the number of rounds fired is reduced by half, so then is the number of vehicles required to

transport the rounds, the number of mechanics to maintain the vehicles, and so forth. The demand on CSS also is reduced in other ways, simply because enhanced C^3I allows the more efficient use of resources. Take fuel, for example. Today, much is consumed in the movement of forces responding to an unclear battlefield situation—reserves sometimes move two or three times in response to an attack that never materializes. If we have a much better idea of what's happening on the battlefield, we can avoid much of this unnecessary movement.

Reducing the uncertainty of the battlefield also reduces the amount of combat service support. Today, we deal with uncertain demand for CSS by building up the largest stocks possible—units create "iron mountains" of ammunition, repair parts, and everything imaginable before undertaking operations. If enhanced C^3I allows us to predict the time and place of demand much more accurately, then we can reduce stockages accordingly without accepting higher levels of risk. The point is that tremendous leverage (multiplying effect) lies in the ability to expend resources more wisely, particularly in terms of reduced CSS requirements. Thus the "tooth to tail" ratio (fighters to supporters) of precision-warfare forces should be significantly improved over today's forces.

C^3I elements—the "brain, sense organs, and nervous system" of precision-warfare forces—are the only elements that require an increase in numbers. However, C^3I is an area in which technology can provide greatly increased capability with minimal increases in physical structure.

Enhanced Mobility. Precision-warfare forces require the agility to exploit the new battlefield visibility, to act on battlefield information. Agility demands greater mobility, both tactically and operationally. While today's forces have significant tactical mobility, their dependence on heavy logistical support greatly limits their operational and strategic mobility. Precision warfare allows creation of a more mobile force in several ways. Tactically and operationally, precision-warfare forces operate in smaller but more lethal elements, allowing them to use more limited avenues of approach, such as secondary road nets. The more limited logistical demand eliminates a considerable amount of the logistical tail that reduces operational and strategic mobility.

Strategic mobility—the key to rapid force projection overseas—also is greatly increased. Because precision warfare provides greater combat potential from a given portion of force structure (that is, more "bang per pound" of force structure), less strategic lift is required.

Enhanced AirLand Battle Doctrine. An army's operative paradigm is the basic view of the military world that determines doctrine, tactics, weapons, and force structure. Doctrine, the tangible written expression of an army's approach to warfighting, is clearly affected greatly by its underlying paradigm. What then is the impact of precision warfare on the US Army's AirLand Battle Doctrine? The complex relationship between a warfighting paradigm and doctrine is addressed in greater detail in the next section. However, I would argue here that a synergistic relationship clearly exists between the precision-warfare paradigm and AirLand Battle Doctrine. Indeed, much of the thinking that underpins AirLand Battle Doctrine plants the seeds for the new paradigm—we are faced with a typical "chicken or egg" argument.

What is clear, however, is that acceptance of the precision-warfare paradigm makes it much easier to achieve the four basic tenets of AirLand Battle Doctrine: depth, initiative, agility, and synchronization. In fact, the new technological opportunities expressed in the paradigm provide the keys for optimizing the advantages of AirLand Battle Doctrine. For its part, AirLand Battle Doctrine provides, for the first time, a forward-looking doctrinal construct capable of accommodating the paradigm.

APPROPRIATE PARADIGM FOR THE NINETIES AND BEYOND?

If precision warfare is a version of Liddell Hart's maneuver-warfare paradigm—updated to take advantage of today's technological realities—then it is arguably well suited for the type of maneuver-warfare environment that we faced in Europe for the 45 years of the Cold War. Precision warfare would have served us well if we had fought the Soviets at the Fulda Gap in

central Germany. But does it meet the needs of the strategic environment that the United States faces in the post-Cold War era? If we adopt the precision-warfare paradigm, do we make Braddock's mistake of having a great paradigm, but for the wrong war?

Because we truly stand at "first light" in the dawn of the new strategic era, this question is difficult to address. The first outlines of our new strategic landscape are just beginning to emerge from the mist, but precision warfare shows significant promise for answering the new challenges.

Strategic and Operational Mobility Challenge. During the Cold War, our strategy used relatively large forward-deployed forces to deter aggression in Europe and the Far East. With the decline of the Soviet threat, neither the American public nor host nations are likely to support forward deployment of the same magnitude. In Europe, the withdrawal of Soviet forces from Eastern Europe also has moved the theater of possible conflict almost 600 kilometers (372 miles) to the east, far from the logistical infrastructure we built over the decades of defending the Inner German Border.

As the Persian Gulf crisis demonstrated, we also face significant threats from armored-mechanized forces of regional powers. In the future, the spread of nuclear- and chemical-weapon technology, together with a cascade of second-hand Cold War weapons, will make it possible for countries with enough money and an adequate population base (such as Iraq) to develop significant military clout. Unfortunately, we also will have to meet these regional threats in theaters far removed from our continental-US support base. Some argue that with the collapse of the Soviet Union we would have at least two years of strategic warning against any potential threat to Europe; therefore, we can reduce military readiness. I would counter that today's strategic environment is less certain than it was during the Cold War.

While Soviet collapse reduces the seriousness of the threat to the United States, it also eliminates much of the stabilizing structure of the bipolar Cold War world. Therefore, in Europe and other areas of vital strategic interest, we may face threats

that are less serious—but much less predictable—than the old Soviet threat. As we learned in the Gulf War, these threats can literally blow up overnight. Unfortunately, our ability to respond rapidly is limited. For the future, we need forces with strategic and operational reach *and* the lethality to fight outnumbered and win. Therefore, we are squarely on the horns of the historic firepower vs. mobility dilemma, brought starkly home by the Iraqi invasion of Kuwait.

When President Bush drew his famous "line in the sand" to thwart the potential advance of Iraqi forces into Saudi Arabia, the line was held for several weeks by only the lightly armed and relatively immobile 82nd Airborne Division and a Marine Expeditionary Force. The airborne division, even backed by considerable air power, was no match for the heavy Iraqi armored forces poised north of the Saudi border. Had Saddam Hussein elected to invade Saudi Arabia, this light infantry force—the only type of Army force that could be rapidly deployed by air—would have been quickly overrun. This force imbalance created an extremely dangerous period of vulnerability that ended only when reinforcing heavy armored and mechanized forces arrived by sea several weeks later.

The precision-warfare paradigm, which tells us how to pack much greater potential into a smaller force package with a smaller logistics tail, offers an answer to this firepower vs. mobility dilemma. And we may need such an answer in the not-so-distant future.

Limited Resource Challenge. Both the declining Soviet threat and the inability to set the Federal financial house in order have mandated a one-third cut in Army force structure over the next five years. But we still face significant challenges. Just meeting the Iraqi threat has placed the Army under great strain—with our current force structure.

Here again, the precision-warfare paradigm offers an answer. If we can increase the force *potential* of our remaining force structure, we need not suffer a decline in overall force capability. We can do more with less, by doing it smarter.

Limited National Will Challenge. The soul-searching that the US Government and the American people went through in making the decision to use force in the Gulf War shed some interesting light on our willingness to fight to support national interests. Once we determined that our interests were strong enough and the villain heinous enough, we faced the question of how high a price in lives we were willing to pay to eject Saddam Hussein from Kuwait. Almost every opinion poll and congressional vote indicated that the willingness to fight declined in almost geometric proportion to the projected number of casualties.

It is increasingly evident that national will begins to evaporate once the body bags start coming home. We are even becoming less willing to shed the blood of aggressors or to inflict high levels of "collateral" damage on enemy civilians, evidence of the increasing trend in western (maybe all) societies to place higher and higher values on human life. The understandable American desire for "bloodless" war clashes directly with the greatly increased lethality of the modern battlefield. However, precision warfare—with its potential to reduce not only friendly but also enemy casualties—offers a means to sustain national will even during limited but intense conflicts we are likely to face in the future.

INTO THE FUTURE

The end of the Cold War, the Gulf War, rapid technological change, and the imminent reduction of the Army to its smallest size since 1939 present intellectual challenges of daunting dimensions. How should our Army fight in the highly lethal environment of the modern battlefield? What should it look like? How can we meet all the challenges ahead of us with declining resources?

The precision warfare paradigm offers a promising approach to these challenges. But how do we get there from here? How do we move the Army toward a new, more useful paradigm.

V. GETTING THERE FROM HERE

THE HISTORICAL ANALYSIS presented in section II here identified three steps that armed forces have followed in shifting to new, more useful paradigms.

—*First,* technological change provides a revolutionary improvement in battlefield capabilities that has the *potential* to fundamentally alter the nature of warfare.

—*Second,* some group or individual recognizes and articulates this *potential* fundamental change.

—*Third,* the armed force exploits the change.

To chart the course leading our Army to precision warfare, we first need to understand where we stand today in terms of these three steps. The following in-depth look at how armed forces have shifted to new paradigms in the past will help us understand how far along we are today. No historical analogy is ever perfect; however, German development of the *blitzkrieg* is an excellent example of how an armed force shifted to a more effective paradigm—an example that sheds significant light on today's challenges. While the *blitzkrieg* was developed under the specific historical, technological, and societal circumstances of its time, some of the underlying factors that allowed Germany to shift to the new, more effective paradigm may be relevant today.

PARADIGMS AND DOCTRINE: SETTING THE STAGE FOR BLITZKRIEG

In the argument presented thus far, doctrine follows from the prevalent warfighting paradigm. In reality, this argument is overly simplistic—a change in doctrine often reflects emergence of a new paradigm. To understand how this emergence happens, we need to look at the relationship between paradigms and doctrine.

A paradigm, says Kuhn, is the common set of beliefs shared by practitioners in any field. In the military world, paradigms are often so taken for granted that they are not explicitly stated. They are just "understood" by everyone. Many officers and military theorists base their reasoning on these beliefs without consciously thinking about them—or challenging them. We just don't operate very often at the paradigm level of abstraction, and it is rare to find a written description of a warfighting paradigm. Therefore, understanding of an armed force's warfighting paradigm must be derived from an analysis of its doctrine, tactics, and actual operations—tangible expressions of its operative paradigm.

German Doctrine Development during World War I. The German change in doctrine during World War I provides an excellent historical example of how a doctrinal change can open the way for acceptance of a new paradigm. In this case, German efforts to adapt their doctrine to the new realities of the World War I battlefield laid the foundation for development of the *blitzkrieg* as their operative paradigm for World War II.

The opening months of World War I came as a major shock to all the European armies. Steeped in the offensive Napoleonic paradigm that had seemed to be the key to victory during the last major war, the Franco-Prussian War of 1870-71, they failed to appreciate how much the new technologies strengthened the *defense*. All the major armies had fielded the new technologies—bolt-action rifles, machine guns, and, particularly, artillery. Improvements in range, projectiles, recoil mechanisms, sights, and telephonic communications between observers and guns had made artillery truly an effective indirect-fire weapon. However, the most effective and heaviest guns were not very maneuverable and required vast quantities of ammunition, moved over extensive transportation systems.

To a large extent, the immediate offensive plans of both Germans and Allies were thwarted by the unexpected superiority of the defense—enormously strengthened by the devastating firepower of the new artillery. The initial German effort to envelope the Allied armies collapsed—then Allied counteroffensives

were checked. Shocked and exhausted by the opening months of the war, both sides dug in to escape the horrendous, unexpected lethality of the new battlefield. By Christmas of 1914 their trenches stretched from Switzerland to the Belgian coast. With their prewar illusions of offensive grandeur shattered by the bloody reality of the battlefield, both sides began the urgent process of adjusting to modern warfare. The Allies sought to maintain their offensive orientation by using massive artillery firepower to clear the way for large-scale infantry assaults. The strategic situation, however, forced the Germans to focus on defense.

The war with Russia on the Eastern Front tied up a major portion of the German Army, and Germany's much smaller industrial capacity further constrained German offensive intentions in the West. Consequently, the Germans were forced to adopt a strategic defense against the Allies. After several months of heavy losses (both sides lost heavily on the Somme), the German Army quickly and effectively developed a new defensive doctrine to cope with the reality of the Western Front. The speed with which the Germans adapted to the modern battlefield is directly attributable to the mental flexibility of their officer corps.

Wartime propaganda has contributed to today's stereotype of the World War I German officer corps as unimaginative, rigidly disciplined automatons who acted only on orders of the General Staff—caricature Prussians in their spiked helmets. In reality, this image was far from the truth. Throughout the war, the Imperial German Army was much more innovative and flexible in developing doctrine than its opponents, enabling the Germans to incorporate ideas from the full breadth of the officer corps, from frontline soldiers, and even from the Allies.

This intellectual flexibility allowed the German Army to develop and employ a highly effective defensive doctrine, the elastic defense-in-depth that was based on new realities of the battlefield. This defense kept the bulk of German forces out of the fixed range of the immobile Allied artillery. Allied attacks were allowed to penetrate the deep German defensive zone until the Allied infantry was beyond effective Allied artillery support, but within range of German artillery. Supported by their own artillery,

the Germans then vigorously counterattacked out of their reserve positions and eliminated the exhausted Allied infantry. Immense Allied casualties from years of fruitless offensives attest to the effectiveness of this German defensive doctrine.

But the doctrine itself reflects a superior German understanding of the changed nature of warfare. They understood the effect of observed artillery fire combined with barbed wire and machine guns. They understood the importance of terrain that allowed observed fire, of avoiding enemy observed fire while subjecting the enemy to its full effects. The German Army understood the impact of technological changes and adapted accordingly—the Allies were much slower and much less effective in reacting and continued to depend on massive firepower and the offensive spirit. When the strategic situation shifted in 1918, this German "paradigm superiority" almost cost the Allies the war.

In late 1917, the German Army High Command saw a window of opportunity developing that might allow them to win the war by a massive strategic *offensive*. If they attacked in the spring of 1918, using forces freed from the Eastern Front by the Russian collapse, they thought they might defeat the Allies before US forces arrived in Europe in decisive numbers. But the High Command was faced with the tactical dilemma that had stalemated the Western front since 1914—how to create a breakthrough and subsequent penetration of the enemy line when the new lethality of the battlefield greatly favored the defense. In developing their defensive doctrine, the Germans recognized the changed nature of warfare (the first step in a paradigm shift) and sought a compatible new offensive doctrine.

Borrowing heavily from a captured French document (written by a frontline French captain and ignored by senior Allied commanders) and their own extensive tactical experience in counterattacks, the Germans came up with a radically different approach to the offense. They had watched the Allies expend massive firepower and precious manpower in futile efforts to break German defenses and had rejected the brute force frontal attack. Instead of massive, days-long artillery barrages that the Allies used to open the way for their attacks, the Germans adopted much more

precise and intense, but short, preparatory fires to disrupt, not destroy, the defense. This tactic allowed them to use their much more sparse fire support more effectively on critical targets and also eliminated the warning provided by long preparatory barrages.

The Germans also abandoned massive frontal assaults—so vulnerable to artillery and machine guns—for tactics based on the infiltration of small units through weak points in the enemy line. Using specially trained and organized, and heavily armed, "storm" units supported by well-coordinated artillery fire and air support, the Germans penetrated as deeply as possible into Allied positions. Storm units punched narrow holes in the defense with their own and supporting firepower, bypassed any strong resistance, and concentrated on disrupting the continuity of the enemy defense by maintaining the momentum of the attack and penetrating the entire enemy position.

These infiltration tactics initially gave the Germans a huge tactical success—they came dangerously close to achieving a strategic penetration. However, superior Allied resources and German shortcomings eventually led to German collapse. Lacking tanks and other mobile fire support (General Erich F.W. Ludendorff decided Germany couldn't afford tanks), sufficient transportation, and flexible communications, the Germans were not able to sustain the momentum of their attacks. Their new doctrine was sound in that it recognized the new realities of the battlefield, but they lacked the wherewithal to execute it effectively.[34]

On to Blitzkrieg. With this doctrine, the small postwar German army provided fertile ground for the thoughts of Liddell Hart and other proponents of mechanized warfare. Even Heinz Guderian, the German father of *blitzkrieg*, acknowledged his indebtedness to Liddell Hart.[35] In a large sense, mechanized warfare provided the wherewithal to optimize the German World War I doctrine, but the *doctrine* provided the mindset that allowed the Germans to see the important advantages of mechanized warfare. The postwar German Army did not sign up en masse for mechanized warfare—far from it. It did, however, have sufficient mental flexibility and intellectual freedom to pursue ideas that eventually led to the *blitzkrieg*.

The Versailles Treaty left Germany with a 100,000-man army, no right to fortify its borders, and surrounded by potential enemies. Searching for ways to defend their country under these new circumstances, the German Army began a series of small, low-key studies and exercises on mechanized warfare. Guderian, a relatively junior officer with little technical background but significant combat experience, was a member of the first study group and soon became the German Army's expert on mechanized warfare. In his words, "in the country of the blind, the one-eyed man is king."[36]

Guderian borrowed extensively from Allied World War I experience with tanks and Liddell Hart's writings in developing his concept for the *blitzkrieg*. He was particularly impressed with the British use of tanks during the battle of Cambrai in November 1917. During this battle, the British massed tanks followed by infantry to punch through the Hindenburg Line. Launched with no telltale preparatory barrage and moving over unbroken terrain, the tank attack was uncommonly successful and almost made the sought-for strategic penetration. Unfortunately, it was one of the very few occasions where tanks were used en masse—most of the time they were spread out to support the attacking infantry. But from Cambrai Guderian learned the lesson the Allies didn't: the value of massed armor in making a breakthrough.

From Liddell Hart's writings, Guderian developed the idea of also using armor to exploit the breakthrough with a deep strategic penetration through the entire enemy defense. He also borrowed Liddell Hart's idea of combining armored forces and mechanized infantry in one division.[37] The key point of Guderian's thinking was the use of armor (*panzer*) forces as the "arm of decision," organized into "armored divisions which would include all the supporting arms needed to allow the tanks to fight with full effect."[38] Unsurprisingly, this point created intense opposition to Guderian's ideas throughout the army—his new *panzer* forces threatened the traditional roles of the infantry and the cavalry.

Despite significant opposition, Guderian was supported by enough "forward thinkers" in key positions to continue his work by developing *panzer* concepts and testing them in modest

exercises, often with "dummy" equipment. When Adolph Hitler became Chancellor in 1933, several armor force supporters rose to the top of the *Wehrmacht* and gave Guderian his big opportunity. When he was allowed to demonstrate his new *panzer* forces to Hitler, the *Fuhrer* was ecstatic, saying repeatedly, "That's what I need! That's what I want to have!"[39] Hitler's support for armored forces was critical. Again and again, opponents both in the German Army bureaucracy and the Army High Command threatened to thwart or even destroy the *panzer* concept. In each case, Hitler personally intervened on behalf of Guderian and the other masterminds of *blitzkrieg*.

With Hitler's support, the German Army went on to exploit the *blitzkrieg*, but this exploitation was neither smooth nor complete. In fact, the plan that created the breakthrough in France in 1940 by keeping the *panzer* divisions en masse was adopted only after the original plan, which dispersed the *panzers*, fell into enemy hands.[40] Even Guderian's important concept of fully mechanized supporting arms (infantry, artillery, and engineers) to support the armor was never fully implemented. Heavy artillery remained horse-drawn throughout the war, often causing *panzer* units to outrun their fire support.[41] Despite the difficulty and incompleteness of its transition to *blitzkrieg*, Germany remained several years ahead of its enemies in exploiting the new paradigm.

Three Steps to Blitzkrieg. Thus, the German army, which had institutionalized a new, "truer" warfighting paradigm in its World War I offensive doctrine, was able to pursue the logical extension of the paradigm to *blitzkrieg*. The German World War I doctrine recognized the total impact of tremendous battlefield lethality and offered a solution to the exceptional strength of the defense. German infiltration tactics used small, mobile, heavily armed storm units, supported by precise artillery fire and air to breach the defense by shock action before enemy artillery and machine guns could take their toll. The army then penetrated the full depth of the enemy defense, destroying the enemy artillery and paralyzing his command and control.

In mechanized warfare, the Germans saw the opportunity to incorporate new technologies of the tank, radio, and aircraft to

optimize this solution. The tank provided the mobility, firepower, and protection that the World War I infantry storm troops lacked. The tactical radio allowed much improved coordination between the tanks and their supporting artillery and aircraft. Fully motorized *panzer* divisions had the mobility and strength to complete the penetration through the depth of the defense. Thus, in completing development of the *blitzkrieg,* Guderian and his compatriots essentially completed a new warfighting paradigm offering a far superior understanding of the tremendous opportunities that technology provided to warfare. But their World War I doctrine provided the key catalyst for their thinking—it allowed them to see *how* the new technologies should be used to *what ends.*

German development of the *blitzkrieg* followed the three steps for exploitation of technological change outlined earlier. First, industrialization and mechanization of warfare provided the "engine of change" that had the potential to revolutionize warfare. Guderian's work was the second step—articulation of the new paradigm. When Hitler overruled the conservative elements of the *Wehrmacht* leadership and forced implementation of the *blitzkrieg* doctrine throughout the force—the third and final step—Germany was able to exploit the new paradigm.

The conceptual preparation that German World War I doctrine provided for *blitzkrieg* was all-important. Although some of the more conservative senior officers initially resisted *blitzkrieg,* more far-thinking officers immediately recognized the advantages. One of the leading practitioners of *blitzkrieg* took command of *panzer* forces for the first time less than three months before leading the 17-day blitz across France in 1940. His name was Erwin Rommel.[42] In fact, the mental facility to accept a new warfighting paradigm and to think through its implications is the key determinant of a force's ability to exploit a new paradigm. Rommel, for example, attributes much of his early success against numerically superior British forces in North Africa to British difficulty in comprehending mechanized warfare.[43]

AIRLAND BATTLE DOCTRINE AND PRECISION WARFARE

If German World War I offensive doctrine set the stage for *blitzkrieg,* what, if anything, does the US Army's current AirLand Battle doctrine do for precision warfare? What is the relationship between the two? I would argue that AirLand Battle can set the stage for precision warfare, just as German World War I doctrine set the stage for *blitzkrieg.*

Development of AirLand Battle Doctrine. In the early eighties, senior US Army leadership began to search for a new doctrine. Its old doctrine, Active Defense, was not only limited in applicability to Western Europe but also offered little hope for defeating the numerically superior armies of the Warsaw Pact. The Army needed a doctrine that—

—Met its requirements for offensive and defensive operations worldwide across the full spectrum of conflict.

—Recognized the highly lethal nature of the modern battlefield.

—Took full advantage of US technological superiority to defeat more numerous adversaries.

—Reintroduced the concept of operational art, linking tactical operations to strategic objectives, to American military doctrine.

The result was AirLand Battle doctrine, a maneuver warfare doctrine based on both an incisive historical analysis and a recognition of the technologically wrought change on the modern battlefield.

New Doctrine, New Paradigm. Like German World War I offensive doctrine, AirLand Battle did not explicitly state a new warfighting paradigm. However, a basic understanding of the potential of the new precision warfare paradigm is, in fact, implicit in the new doctrine. AirLand Battle can show us *how* the new technologies should be used to *what ends.* Consider the stated objective of AirLand Battle:

> The object of all operations is to impose our will on the enemy....To do this we must throw the enemy off balance with a

> powerful blow from an unexpected direction, follow up rapidly to prevent his recovery and continue operations aggressively....The best results are obtained when powerful blows are struck against critical units or areas whose loss will degrade the coherence of enemy operations in depth, and thus most rapidly and economically accomplish the mission.[44]

Here, AirLand Battle Doctrine sounds very much like a concise statement of Liddell Hart's maneuver warfare thesis. But AirLand Battle goes further by stating that accomplishment of this objective depends on ability to fight according to four basic tenets:

—*Initiative:* setting or changing the terms of battle by action.

—*Agility:* ability of a force to act faster than the enemy.

—*Depth:* extension of operations in time, space, and resources.

—*Synchronization:* arrangement of battlefield activities in time, space, and purpose to maximize combat power at the decisive point.

And these basic tenets—the "how to" of AirLand Battle doctrine—show an implicit understanding of the precision-warfare paradigm, because they reveal the ends toward which we should point the new technologies. Recall the central thesis of precision warfare: the ability to collect, analyze, disseminate, and act on battlefield information has become the dominant factor on the battlefield, displacing shock action and massive firepower from their position of preeminence. Note that this thesis states the change in the relative importance of these factors—shock action and firepower remain important factors.

AirLand Battle's implicit understanding of this precision-warfare thesis becomes clear when we look at the underlying requirements for each basic tenet of AirLand Battle.[45] In virtually every case, the requirement depends on management of battlefield information in some manner, not firepower or shock action.

Initiative. Looking first at the requirements for *initiative*, setting or changing the terms of battle by action. Initiative requires subordinate commanders to operate within the framework of the

higher commander's intent while they fully exploit tactical opportunities that develop. This style of operating can only be achieved by rapid exchange of battlefield information—orders down, information up—so that commanders at all levels fully understand what's happening on the battlefield and what the higher commander wants to happen. Initiative also requires anticipation of likely enemy courses of action. Such forewarning can only be achieved by in-depth, timely knowledge of the enemy—knowledge derived from rapid collection and analysis of battlefield information. Violent execution—knocking the enemy off balance—is also essential to initiative. Violence is achieved by the sudden, coordinated, and precise application of firepower or shock action on targets that paralyze and destroy the cohesiveness of the enemy force. Here, collection, analysis, and dissemination of battlefield information—coupled with ability to react rapidly to that information with precise firepower or rapid maneuver—is key to success. To gain and maintain the initiative, a commander must be audacious, as true today as in Napoleon's time. But audacity is not reckless risk taking—far from it. Instead, it is shrewd assessment of potentials of the battlefield and a willingness to act on these potentials. Clearly, the commander who has the most complete and timely battlefield information will make the best assessments. With more and better information, he will be more willing to act and seize the initiative.

Agility. The ability to act faster than the enemy, is the second basic tenet of AirLand Battle. It, too, depends extensively on a force's ability to manage battlefield information. To be agile, a force must be able to cut through the fog and friction of war and continuously read the battlefield. The commander must be able to reach decisions and issue orders rapidly. The key here is the speed with which "enough" information reaches the commander for him to reach a decision. Many battles have been lost because leaders waited for complete information—and missed great opportunities. To be agile, units must be physically and psychologically capable of rapid reorientation and movement. While physical mobility is a major factor, knowledge of what's happening throughout the battlefield, even beyond the unit's

immediate location is absolutely critical. The more timely the knowledge of an impending change on the battlefield, the better a unit's reaction will be.

Depth. The third doctrinal tenet, *depth*, also shows the relationship between AirLand Battle requirements and precision warfare. Depth, the extension of operations in space, time, and resources, is particularly information dependent. For example, it requires anticipation of future friendly activities. This foreknowledge is a function of the ability to disseminate information, especially from higher to lower and supported to supporting units. Extension of the battlefield in both time and space depends on reconnaissance beyond the immediate battle area and attack of uncommitted enemy forces and support facilities. Here again, the force must be able to collect, analyze, disseminate, and react to battlefield information to attack enemy elements that are not yet in contact with friendly forces but will influence the battle in the future. For example, a friendly force defending against an enemy attacking in two or more echelons must fight not only the first echelon (with which he is in contact) but also the second echelon. Otherwise, the friendly force risks defeating the first echelon only to be overrun or bypassed by the second. On the fluid battlefield, extension of the battlefield in terms of resources requires continuity of sustainment, which depends largely on the rapid dissemination of information on what needs to get where in what priority.

Synchronization. Achieving *synchronization*, the fourth basic tenet, also relies heavily on battlefield information. To synchronize the efforts of his various elements, the commander must understand the complementary and reinforcing effects of combined arms. From the battlefield perspective, this understanding means he must have immediate information on the mission status of each supporting element. For example, has artillery suppressed defensive fires so engineers can move forward to breach an obstacle? When and where will the engineers be able to breach? Can supporting aviation prevent an enemy counterattack on the breaching location? Synchronization also requires knowledge of the relationship between friendly and enemy capabilities

and mastery of the time-space relationships among these capabilities. For example, the commander must know which force will reach a critical decision point when with what capability and what actions can be taken to influence the movement of both sides. On the rapidly changing battlefield, synchronization of effort also requires that commanders at all levels have an unambiguous and timely understanding of the purpose of operations. This level of understanding depends on timely transmission of the commander's intent, which can change significantly as the action progresses.

* * *

From this analysis of the basic tenets of AirLand Battle doctrine, the relationship between doctrine and the precision-warfare paradigm becomes clear. Achievement of each basic tenet depends absolutely on management of battlefield information. Therefore, AirLand Battle doctrine is absolutely consistent with the thesis that the ability to collect, analyze, disseminate, and act on battlefield information is the dominant factor on the battlefield—the precision-warfare paradigm.

Thus, just as German World War I doctrine provided the intellectual basis for developing *blitzkrieg,* AirLand Battle doctrine gives us the intellectual basis for accepting precision warfare as our basic warfighting paradigm. German World War I doctrine showed how firepower and shock action could rapidly create breakthroughs at weak points. Fast moving forces could then exploit these breakthroughs to penetrate the depth of a defense, paralyzing the enemy and fracturing the cohesion of his defense. In this way, the attacker could avoid the technologically created strength of the defense and attack successfully without insufferable casualties. World War I doctrine thus showed how the new technologies should be used. Firepower, mobility, and survivability of tanks should be massed to make the breakthrough; combined arms mechanized forces should then exploit to create a penetration. Dive bombers should provide flexible and responsive firepower to assist tanks in breaking through. Tactical radios should coordinate efforts of the entire force. Thus, technology should be used to allow the application of the doctrine to its full potential.

The relationship of AirLand Battle to today's new technologies is analogous. The doctrine shows us *how* to apply the new lethality and visibility to warfare to achieve key factors for winning—the four basic tenets of *initiative, agility, depth,* and *synchronization.* Understanding that proper application of the new technologies will allow exploitation of AirLand Battle doctrine to its full potential requires acceptance of the precision-warfare paradigm, the thesis that in modern *precision* warfare, the ability to collect, analyze, disseminate, and act on battlefield information is the dominant factor on the battlefield.

Many will argue that AirLand Battle is *not* a revolutionary doctrine. In fact, its authors specifically state that it is historically based, with its tenets derived from analysis of past military operations throughout the ages. I absolutely agree. What is revolutionary is the ability of technology to provide the means to achieve the tenets of the doctrine. For the flip side of that argument, AirLand Battle is an historically based maneuver-warfare doctrine with potential to show us how to apply new technologies to the greatest advantage on the tomorrow's battlefields.

WHERE WE NEED TO GO FROM HERE

So—where do we go from here? With AirLand Battle doctrine, we are now in the middle of the second step in shifting to the precision-warfare paradigm. In showing that the new technologies—used according to the new doctrine—can vastly increase combat potential, we are in the process of recognizing and articulating the fundamental change in the nature of warfare. We have a forward-looking doctrine that accommodates the new warfighting environment wrought by rapid technological change.

Where We Are Today. The new technologies provide the means for optimizing the advantages of AirLand Battle doctrine, just as tank, radio, and aircraft made it possible to optimize the advantages of the German doctrine of late World War I. Technological achievements, particularly in C^3I, have made it possible for forces—trained, organized, and equipped to fight

AirLand Battle—to fight, survive, and win in the highly lethal environment of today's battlefield. AirLand Battle doctrine, supported by enhanced C^3I and precision fires, can do for the commander of the nineties what *blitzkrieg* and mechanized forces did for the commander of the forties—liberate him and his soldiers from the disaster of attrition.

The First Step. How, then, do we complete the statement of the precision warfare paradigm and move on to exploitation of the paradigm? First, we must institutionally recognize the power of our new doctrine—its potential, optimized through technological innovations, to provide a quantum jump in force potential. We must recognize that in the nineties, forces fighting according to AirLand Battle doctrine, organized, equipped, and trained to optimize the application of new technologies, have the potential to change warfare as much as *blitzkrieg* and the mechanized forces of the *Wehrmacht* did in the early forties.

This recognition depends on explicit statement of the new precision-warfare paradigm and AirLand Battle's relationship to it. In short, we must shift to the new precision-warfare paradigm, which expresses both the harsh realities and immense potential of the ultra-lethal modern battlefield. This challenge is of the first magnitude, one that an army only faces a few times in its history. To shift to the precision-warfare paradigm, we must first convince the Army's leadership, all the way down to platoon-leader level, that this approach permits more effective application of even today's combat systems. But convincing leaders trained and conditioned to think one way to shift to a new way of thinking is very difficult—a dominant paradigm has tremendous power.

Fortunately, a few factors will help the effort to shift to the precision-warfare paradigm. From the outset it must be clear that adopting a new warfighting paradigm does not mean either "unlearning" everything or junking a sizable portion of our existing force structure. The principal focus is not on the components of the system; it is, rather, on a new conceptual framework that permits these components to work together in more effective ways. Thus, in transitioning from the Ptolemaic to the Copernican model of the universe, the "facts" did not change—

the new model simply made it easier to understand and work with the "facts." "State of mind" is more important to the new paradigm than the presence of a particular lineup of hardware. With a "truer" model of reality in our minds, we will automatically begin to steer the Army in the direction it must go.

To shift minds raised on the "old" model to a newer one may require considerable mental effort. Such massive undertakings within our Army have previously benefitted from a readily appreciated external push, such as the fall of France to the German *blitzkrieg* in 1940. Today, the Gulf War, one of the most one-sided victories in military history, has the potential to provide the essential push. How well we seize this unique opportunity remains to be seen—the subject of the last section. Most of all, we need to get our own "Guderians" thinking, writing, and otherwise advocating precision warfare. As demonstrated in the Gulf War, we have enormous intellectual potential in our Army—we need to harness it to this critically important task.

Pitfalls. The greatest challenge for our precision-warfare "Guderians" will not be making the case for the new paradigm. Rather, the greatest challenge will lie in convincing "the authority" to exploit the change in our Army. In our democratic society, power is intentionally fragmented to provide a balance and prevent domination of society by any one person or group, particularly the armed forces. Consequently (and fortunately), we have no one Fuhrer who can force the Army to adopt a new warfighting paradigm. Instead, we have numerous elements of authority—such as senior Army leadership, the Department of Defense (DOD), and Congress—each with a different agenda and different interests, that must be convinced to adopt precision warfare.

As is always the case with paradigm shifts, precision warfare will generate a tremendous debate within the Army, the DOD, the Congress, and even the nation at large. How well the Army manages this debate over fundamental change in warfare may have a significant impact on its ability to adapt. The door is wide open for sensationalism and emotionalism.

Speaking of the Chinese social revolution, Mao Ze-dong once said, "you cannot make an omelet without breaking eggs"

and "revolution is not a tea party." The same also applies to a revolution in military thinking. Virtually every officer who has made a career under the current system and every bureaucracy that depends on the current method of doing business may feel threatened by the very proposal of a new warfighting paradigm. There is even the potential for a modern "Billy Mitchell" incident, in which some "young Turk" in or outside the Army attempts to "prove," by spectacular means, the obsolescence of some hallowed weapon system—like General Mitchell did in his experimental bombing attacks against battleships.

The ensuing rancor, coupled with the unguided and unnecessary debate that would follow, could well stifle debate on the larger question for the near term, as was true in the Mitchell case.

Domestic Political Implications. The American public is fast losing patience with current developmental and procurement procedures. While some of this unhappiness is due to press sensationalism, much also is due to the high unit costs of what will probably be the last generation of equipment produced under the traditional paradigm. Because much of our current research and development involves gradual, evolutionary change within the current paradigm, we have been chasing "perfection" on the flat, upper limb of the effectiveness curve, where marginal increases in effectiveness will not offset associated costs.

Even before the Gulf War, Congress, particularly the military reform movement, was concerned with how the military was going about adapting to technological change. Military reformers accused the military of technological "gold plating"—buying the latest (and most expensive) technology for its own sake, rather than because it filled a valid military need. Thus, military forces were acquiring fewer, more expensive, less reliable weapons, they said, with no clear idea of how to use them. The reformers advocated return to military fundamentals and reliable, albeit lower, technology and less expensive weapons. The reformers were not necessarily opposed to all Army initiatives for dealing with technological change. In fact, the Army probably had a better relationship with the military reform movement than some of the other, more technologically

intensive Services. However, the reformers did have an independent viewpoint on how technological change should be approached, and they had significant clout on Capitol Hill.

Because of the effectiveness of high technology during the Gulf War, decreasing defense budgets, and increasing costs of technology, a spontaneous debate over the nature and speed of future changes may be in the making. A spontaneous debate, with associated media sensationalism, has the potential to do considerable damage to the Army. Some "armchair strategists" might try to put us on the defensive, the press might try to make us appear foolish, and the public might not know what to think. The consequence could be lack of support for badly needed force modernization programs while the debate rages, so the Army must "do its homework" to seize the initiative, originate the debate, and control the agenda.

ON THE FUTURE ARMY

We must begin with a clear vision of what we want the Army to look like to fight precision warfare. We need to know where we want to go before we set off to get there. One of the major obstacles to acceptance of a new warfighting paradigm is that it conjures up visions of a "Buck Rogers" science fiction army. In reality, an army capable of exploiting advantages of the new paradigm need not be radically different from the army that now exists in our motor pools or in the Army Program.

Like human evolution, the process allowing us to exploit profound change is more a function of developments in our "central nervous system"—C^3I—than in development of physical "muscular" strength. Mankind has evolved with little change in our physical makeup. In fact, we are probably weaker than some of the earlier species of men. Human evolutionary progress has been in development of larger brains and more sophisticated central nervous systems that allow us to think and communicate more effectively. Similarly, a precision-warfare army need not change much in terms of force structure. Today's weapons would work fine in precision warfare. The change would be mostly in incorporation of enhanced C^3I—our "brain

and central nervous system"—that would allow us to apply today's weapons according to the new, more effective paradigm. Fundamental change will not be seen so much in the composition of the force as in force potential.

This potential can only be fully developed by understanding that it is possible to put existing or planned things (doctrine, tactics, weapons, and C^3I) together differently to achieve a quantum jump in effectiveness. In fact, much of the work in doctrine and advanced C^3I and advanced precision weapons, that could allow us to exploit precision warfare, is already well underway. Today's Army, with enhanced C^3I, AirLand Battle doctrine, and *an understanding of the precision-warfare paradigm* could conduct the precision warfare operations described earlier. However, we need to keep several factors in mind as we lead the Army toward the new paradigm.

Key Technologies. First, in spite of fiscal retrenchment, we must at all costs protect developments in the core C^3I capabilities that will allow us to exploit the new paradigm to its full potential. In some ways, our situation is similar to that of the Royal Air Force (RAF) during the late thirties. Faced with limited resources and an increasing air threat from Nazi Germany, the RAF devoted a significant portion of its resources to development and partial fielding of a new, relatively immature but very promising technology—radar. While this very expensive technology provided only a rudimentary ability to "see" the battle, this capability was, in fact, "revolutionary": it hitherto was not available, the enemy did not possess it, and, most significantly, it provided a quantum jump in existing force potential.[46]

Radar allowed the British to exploit a much more effective defensive counter-air-warfare paradigm with almost no changes in their technologically mature fighter aircraft and antiaircraft artillery forces. For decades before the war, the dominant paradigm for air warfare held that the bomber always got through. Fighter defenses were useless because bombers couldn't be detected in time for fighters to get up to altitude to attack them. Thus, the *Luftwaffe* had the ability to devastate British cities virtually unchallenged. Recognizing that such unopposed air attack could defeat them in a future war, the

British began a search for new aircraft detection technologies—and discovered the principles of radar. After a heroic bureaucratic and political battle, it was fielded just prior to the War. The result was recognition and exploitation of a new aerial warfare paradigm based on the ability to see the air battle—and British victory in the Battle of Britain.

Today, we, too, must make difficult choices in the allocation of increasingly scarce resources. To take advantage of the precision-warfare paradigm, we need to prioritize our research, development, and acquisition dollars to focus on those systems that provide the dominant battlefield capability—the ability to collect, analyze, disseminate, and act on battlefield information. But we need to do more than buy the key technologies—we need to ensure that our leaders understand their importance. We haven't always done this well and have suffered accordingly.

The early British effort to export radar to the United States is a good example. In August 1940, at the height of the Blitz, the British sent a high-powered mission to the United States with the mission of convincing American civilian and military leaders of the value of some of their new technologies, particularly radar. The following passage described the reason for the mission and its lack of success:

> The British were aware at the time that though German radar was every bit as technically sophisticated as their own, it was not appreciated by the German military, was not integrated into their war scheme, and so was virtually useless. They hoped to convince the Americans not to make the same mistake. In great measure they failed in this aim: When the Japanese attacked Pearl Harbor, that great naval base was well protected by radar developed to a large extent through the apparatus brought by the ... mission; but it was so little appreciated by the military authorities in Hawaii that its warning of the approaching Japanese forces was ignored.[47]

Dealing with Revolutionary Technological Change. We must also remember that the technologies we're dealing with are, themselves, in a state of revolutionary change, especially information management and automation technologies. Anyone

who has bought a home computer in the last five years knows that increases in capability are growing exponentially over time. This explosive growth has several implications.

To begin with, it means that we must suppress our appetite for what we want the new C^3I systems to do. Time is absolutely of the essence. Today, we sometimes delay fielding new systems until they are 100 percent mature and can provide more information than we can possibly absorb—and end up fielding hopelessly obsolescent equipment. Instead, we must focus on development and fielding of a very few key capabilities that provide a quantum jump in force potential. For example, a maneuver control and intelligence system that displays only friendly and enemy unit locations in real time would provide a major advantage over an enemy without the same capability.

We like to buy equipment—tanks, helicopters, trucks, artillery pieces—that we can use for 20 years or more by making modest improvements in it after it is fielded. And this approach makes good sense, if the technology on which the equipment is based is developing at an *evolutionary* pace. But automation is developing at a truly *revolutionary* clip. Therefore, we need to buy automation with the understanding that we may have to throw it away in only five years or so—a truly revolutionary concept, especially for budgeteers!

Focused Fielding. Next, we must recognize the tremendous synergism between AirLand Battle doctrine, enhanced C^3I, long-range precision weapons, and night vision capability. To make the new paradigm operative, a force must have *all* the required technology, meaning that we must make hard choices to avoid fielding new technologies in "penny packets" throughout the entire Army. Instead, we must first give key units (for example, key contingency division) full suites of the new systems. The Germans used this approach in 1940 and fully outfitted their *Schwerpunkt* (Spearhead) units at the expense of others, while the Allies distributed their armor more equitably throughout the force. The results speak for themselves.

Revolution in Logistics. A third factor that bears remembering is that combat support and combat service support absolutely

must be considered as part of the comprehensive whole of the new paradigm. We can't exploit the advantages of the new model without concurrent developments in these critical areas. We must avoid the mistake the Germans made in fielding their *panzer* forces. In developing the *blitzkrieg*, Guderian made the argument that all supporting arms had to be able to keep up with the tanks—winning depended on the synergistic effects of all arms. But German industry was not able to provide sufficient mechanization—heavy artillery remained horsedrawn and many infantry units were only foot-mobile; support units were in even worse shape. German leadership also remained fixated on the tank and devoted more and more resources to developing heavier tanks. Consequently, German armor was often left in the lurch by supporting arms that just couldn't keep up.

We, too, cannot fight with maneuver units fighting precision warfare while logistical support attempts to keep up with our World War II-vintage logistical system. To fight precision warfare, we must apply the same precision warfare principles of current in-depth battlefield knowledge, rapid exchange of information, and precision application of effort to our logistical system. Arguably, the field of logistics may profit even more than maneuver and fire support by application of precision warfare. With better knowledge of the battlefield, logistic power can be planned and targeted to accomplish more with less. Further, the more precise application of combat power by maneuver and fire-support elements will optimize the return on expenditure of scarce resources, thus reducing the burden on the logistic system. Distributed and redundant command and control also can allow greater dispersal of logistic assets, increasing their survivability.

Full Spectrum of Conflict. Finally, we must understand that precision warfare is applicable for all forces, across the full spectrum of conflict. Lighter forces involved in low-intensity conflict have as much to gain from application of the new model of warfare as heavier forces. In fact, enhanced C^3I and precision long-range fires may provide a proportionally greater increase in the force potential of lighter forces using their higher mobility in constricted terrain. Precision warfare may even make the most

sense in counterinsurgency operations, where the precise application of combat power is essential to avoiding civilian casualties and collateral damage.

FOCUSING THE EFFORT

The Army is now well along on many individual projects that can contribute to shifting to a new, more effective warfighting paradigm. However, we have not yet summed up the ultimate consequence of all of the individual developments in doctrine, tactics, and technology. And we have not placed the consequence, fundamental change in the nature of warfighting, in its historical context.

To date, our approach to exploiting the potential of new technologies has been analogous to trying to produce more light on one particular spot by increasing the wattage of each of a set of many incandescent lights. Because the light produced is unfocused and incoherent, a great expenditure of energy is required to increase the light by a given amount. However, by improving our understanding of the basic nature of light, we can force the light waves to become focused and coherent—to reinforce each other—thereby allowing a smaller amount of energy to produce a much greater amount of light on the required spot. This move requires the conceptual leap from the incandescent light bulb to the laser.

Today, our Army has the intelligence and mental agility to make a conceptual leap of this magnitude. What it needs is the spark of understanding that can be created by expounding a well-thought-through argument for shifting to a newer, more useful warfighting paradigm. It may be that we now have at hand the "flint and steel" to strike this spark—the Gulf War.

VI. THE GULF WAR: THE NEW PARADIGM EMERGES

T WAS CLEAR FROM THE OUTSET that the Gulf War was different from any other war ever fought. Americans listened in live as the first bombs struck Baghdad. Within hours they saw videotapes of laser-guided bombs hitting air vents in fortified buildings in the dark and *PATRIOTs* blasting *Scud* missiles from the skies in Fourth of July showers of fireworks. Finally, they saw the fourth-largest army in the world, that had fought Iran to a standstill for eight years, bludgeoned by amazingly accurate airstrikes for 38 days and then virtually destroyed in a lightning-swift, 100-hour land campaign.

Obviously, something fundamental had changed in the very nature of warfare, but what exactly was it? Was it the quantum improvements in the high-tech weaponry that flashed nightly across the TV screens, or was it something deeper than that?

The history of the Gulf War will be sieved for lessons learned for years to come. At this writing (the summer of 1991) the dust has barely settled and official after-action reports are still being written—it is much too early to draw any definitive conclusions. However, the extent of change was so great and the military victory so overwhelming that it is possible to draw some general, macro-level conclusions even now. It is clear, for example, that the military world has changed and will never again be the same. Even at this early hour, analysis of the Gulf War can help to explain the nature of this change and what it portends for the future. Here, the concepts of warfighting paradigms and paradigm shifts provide a useful framework for analysis.

UNIQUE ASPECTS OF THE GULF WAR

All wars are unique. Each has specific characteristics that will never again be repeated under other circumstances, making it difficult, and a bit dangerous, to draw broad conclusions from analysis of any particular conflict. But in the military art, real, specific wars are all we have—imperfect as they are—to provide definitive support for our arguments. As useful as wargaming and computer simulations are, they will always take second seat to actual combat experience. This dependence on actual, non-reproducible combat events forces us to first separate specific factors and circumstances of the war from factors that might apply to warfare in general. Some of these unique, specific aspects of the Gulf War are discussed below.

Strategic Initiative. In some ways it would be hard to find a war fought under more favorable circumstances for the United States and its coalition allies. First, we were fortunate to fight an enemy led by Saddam Hussein, who insisted on absolute control of Iraqi operations despite his lack of military experience. He had operated the same way during the Iran-Iraq War, with similar disastrous results, and was saved from the consequences only by even greater Iranian incompetence.[48]

Clearly, he didn't learn from his own mistakes. Saddam's ineptness gave the Allies a major strategic advantage on several occasions. Perhaps his greatest mistake was in underestimating American resolve—he apparently never thought that the United States would risk actual combat to liberate Kuwait, causing him to make the mistake of surrendering the strategic advantage that he achieved by seizing Kuwait and threatening Saudi Arabia. In August, he had the opportunity to continue south against minimal opposition to seize most key Saudi oil fields and ports of entry. Had he done so, he would have been in a much better position either to negotiate on his own terms or to oppose the allied deployment to Saudi Arabia. Instead, believing that the United States would not be willing to pay a high price in casualties to liberate Kuwait, he opted to defend in place inside Kuwait. Thus, he surrendered the

strategic initiative to the Allies, allowing them to conduct first a diplomatic and then a military campaign at their own pace.

Because Saddam surrendered the initiative, the Allies had the luxury of fighting a "rich man's war." They were able to take a full six months to bring in an enormous force and the tremendous logistical support to sustain it. The US Army was even able to replace the older model M-1 tanks that were initially deployed with newer M-1A1 models with heavier guns and armor. Holding the strategic initiative at the opening of an actual shooting conflict is almost unique in American military history. In almost every past case, we reacted to a surprise enemy initiative and ended up fighting a "come as you are" war with ill-prepared forces. In the Gulf War, we were able to fight at a time of our own choosing. Most importantly, we used our time wisely to prepare for combat by bringing in essential equipment and training for specific combat missions in the environment we were preparing to fight in.

Qualitative Edge. In the opening phases of most past conflicts we also have lagged behind our enemies in terms of equipment and training. Recall our first battle against the Germans during the North African campaign of World War II. At the Kasserine Pass the tanks of Rommel's battle-hardened Afrika Corps sliced through superior numbers of raw GIs. Our opening engagement of the Korean War was even worse. Task Force Smith, a hastily thrown together battalion task force, was overrun by North Korean tanks—who probably never even realized they were fighting Americans—setting the stage for the ignominious withdrawal of rag-tag American forces to the Pusan Perimeter.

In the Gulf War, we fielded the best led, best trained, and best equipped forces we've ever had. Decades of rebuilding force quality damaged by Vietnam and preparing to fight the Soviets in Europe—and the healthy defense budgets of the Reagan years—gave us the best military forces in the world. By contrast, the numerically superior and relatively well-equipped Iraqi forces were poorly led, poorly trained, and poorly motivated. Officers promoted for political reliability rather than military proficiency sometimes abandoned their men days before

combat began. While some units, particularly the Republican Guard divisions, were well trained and battle-hardened, others were filled with raw conscripts and unwilling reservists.

US and Allied forces also had technologically superior equipment. Their aircraft, tanks, armored fighting vehicles, anti-tank guided missiles, and most other equipment proved to be superior even to Iraq's latest-model Soviet equipment. Iraq's only technological edge lay in long-range artillery. Even here, however, they lacked the sophisticated target acquisition radar needed to make the longer ranges of their artillery truly effective.

Air Superiority. General McPeak, US Air Force Chief of Staff, stated that the Gulf War was the first war in history in which an army was decisively defeated from the air. Whether or not the Iraqi army was *decisively* defeated from the air undoubtedly will be a major point of argument for the next decade, but it is certainly clear that absolute air superiority gave the Allies a decisive advantage in the war. Several specific factors made it possible to achieve this degree of air superiority and to use it to so great an advantage.

—We had greater numbers of more technologically sophisticated aircraft flown by the best trained and led aircrews in the world.

—We had developed the capability to engage point targets with unprecedented precision.

—We could see the air battle with our airborne radar systems and could blind Iraqi air defenses by destroying their radars.

—The open desert terrain made it very difficult for Iraqi forces to conceal themselves. Even where they could camouflage themselves, our airborne infrared target-acquisition systems allowed our aircrews to spot them, even in the dark.

Not only did we *have* absolute air superiority, we also *used* it very effectively. Recognizing that Iraqi command-and-control was centralized in Baghdad, we cut their communications links with their forces in Kuwait. We severely damaged their transportation systems and lines of communication, making it extremely difficult for them to supply and reinforce their

forward units. We also isolated the decisive areas of the battlefield by preventing the repositioning of Iraqi forces.

Finally, we attacked both forward and reserve forces, destroying a major portion (at least half—final figures may be difficult to come by) of Iraqi ground-combat capability, allowing our ground forces to achieve decisive force ratios at key locations.

BUT WHO HAD THE BETTER PARADIGM?

The Allies had numerous other advantages specific to the Gulf War: absolute sea control, the ability to conduct massive amphibious operations, PATRIOT missiles to defeat ballistic missiles, mostly professional forces—the list could go on and on. But does the summation of all of these specific advantages equal the tremendously lopsided Allied victory, whose incredibly swift speed and exceptionally low cost surprised even its architects? After all, many Allied advantages were well understood before actual hostilities began. But casualty predictions still ran on the order of 20,000 or so, with several thousand dead—actual losses were in the hundreds, several orders of magnitude lower. Predictions of equipment losses were as far off. For example, the Iraqis lost thousands of tanks to all causes—US Army tank losses were less than 10.

The point is that prior to hostilities the opposing sides appeared to be much more equal than they actually were, even after factoring out all of the obvious Allied advantages. Clearly, the Allies had another advantage, less apparent but perhaps even more important than those described above: a far superior warfighting paradigm. Historically, the side whose warfighting paradigm best reflects the underlying "truths" of the battlefield achieves a tremendous superiority. The German *blitzkrieg* in France in 1940 and Japanese use of naval aviation at Pearl Harbor are clear examples, but did it happen again in the Gulf War? Did the Allied paradigm better reflect the realities of the battlefield and thus provide a quantum advantage over the Iraqis? A comparison of the two paradigms should tell.

Iraqi Paradigm. Like many military organizations, the Iraqi army in the Gulf was the victim of its own past success. Its

operative warfighting paradigm was based almost exclusively on its highly successful defensive operations against Iran during the eight-year Iran-Iraq War. During the middle phases of this war, when Iraq was defending its own territory, the Iraqis became masters of the defense. Anthony Cordesman's description of Iraqi defenses around Basra illustrates the extent and sophistication of Iraqi defensive operations:

> A line of massive earth berms was set up along the border area east of Iraq's main north-south roads. A large number of lateral roads reached to the forward lines with smaller north-south roads immediately behind the berms. There was a cleared 'fire zone' in front of the berm, and the berms had observation points and fire points all along their top. They were defended by dug-in tanks and large numbers of antiaircraft machine guns and cannon which could be used to 'hose' attacking Iranian infantry. Iraq made extensive use of mortars, minefields, and barbed wire. Where possible, Iraq also began to divert water into the area to create further defensive barriers.[49]

The Iraqis clearly understood how to exploit the lethality of the battlefield, at least against the Iranians. Deprived of its professional military leadership by the purges of Khomeini's Islamic Revolution, the Iranian army resorted to mass infantry assaults that differed little from British and French frontal attacks of World War I. The results were predictable. Stopped by barbed wire and mines and exposed to Iraqi direct fire, artillery, attack helicopters, and fighter-bombers, the poorly trained Iranians were killed in droves. During one day-and-a-half battle alone, the Iranians suffered 9,000-12,000 casualties—Iraqis losses were only 1,000-2,000.[50]

Iraqi successes in the Iran-Iraq war led the Iraqis (particularly Saddam Hussein) to conclude that a well-established defense was superior to any offense—that a force with well-dug-in firepower defended by obstacles would inflict unacceptable losses on an attacker. This Iraqi warfighting paradigm, so reminiscent of World War I, also strengthened Saddam Hussein's view that the "soft" Americans would not attack his vaunted defenses because they were not willing to accept such

high casualties. While Iraq's defense-oriented paradigm sufficed against the religiously inspired but ill-trained and ill-equipped Iranian army, it quickly fell apart against the highly sophisticated forces of the United States and the coalition Allies. With their technological sophistication, the Allies brought to the conflict the full impact of the new dominant warfighting factors—battlefield lethality and battlefield visibility. Iraqi's paradigm took neither factor into full account.

Because the Iraqi vision of warfare was dominated by their experience in the Iran-Iraq war, they were not able to grasp the full implications of Allied ability to see the battlefield—in strategic, operational, and tactical dimensions—and to strike targets with great precision, even at night. The Iraqis saw themselves as a hardened David going up against a timid, inexperienced, flabby, and not so big Goliath. Unfortunately for Saddam Hussein, the Goliath who showed up was a steel-nerved, world-class athlete—armed with a high-powered rifle and laser scope!

American Paradigm. What, then, of the American paradigm? Was it still the World War II-vintage firepower and shock-action paradigm, or was it the more useful precision-warfare paradigm? I would argue that it was a mixture of both. Because underlying paradigms are rarely stated, it is necessary to infer them from a force's doctrine, tactics, and actual battlefield operations. From the doctrine perspective, the Allies, under US leadership, clearly followed US Army AirLand Battle doctrine that reflects the precision-warfare paradigm.

The heart of the planning cell of US Central Command (CENTCOM) was a group of field-grade Army officers referred to whimsically as the "Jedi Knights." These officers were graduates of the Army's School for Advanced Military Studies, a two-year course for a selected number of promising officers that focuses on strategic and operational application of US Army doctrine. It is not surprising, therefore, that the Jedi Knights' final product, the CENTCOM campaign plan for the Gulf War, was almost a pure application of US Army AirLand Battle Doctrine.

Doctrine provides the "how to" for using new instruments of war provided by technology. An outdated doctrine will cause

a force to use new things in old ways, often with disastrous results. A force with a doctrine that best takes into account new technological realities of the battlefield often will use the new technologies to a decisive advantage, which happened in the Gulf War. AirLand Battle doctrine allowed us to exploit our technological edge to the greatest advantage.

Recall from the last chapter that AirLand Battle doctrine can reflect the precision-warfare paradigm that emphasizes the ability to collect, analyze, disseminate, and act on battlefield information over firepower and shock action, stressing the use of the new battlefield visibility to guide our application of the new battlefield lethality while avoiding its effects on our own forces. The doctrine reflects this paradigm by showing us how to use the new technologies to achieve the basic tenets of initiative, agility, depth, and synchronization. In addition to doctrine, tactics and techniques reflecting the precision-warfare paradigm were evident throughout all phases of the Gulf War. However, the first three phases—the strategic air campaign, air superiority campaign, and battlefield preparation campaign that led up to the fourth phase, ground offensive, provide some of the most clear-cut evidence of our understanding of precision-warfare.

Air War. Planners of the *air war* clearly believed in the precision-warfare paradigm and applied their understanding of it with spectacular results. Moreover, they had the tools to collect, analyze, and disseminate battlefield information and to react to that information with amazing speed and precision.

Our ability to see the battlefield was nowhere more apparent than in the air war. Prior to hostilities, we were able to use satellites and airborne-sensor systems to identify the set of Iraqi C^3I targets and other key targets. But these targets were not undefended. While the Iraqi air force was clearly outclassed, Iraq possessed a formidable air-defense system capable of inflicting significant losses to attacking Allied aircraft.

Air planners recognized that C^3I was the linchpin of Iraqi air defenses. Therefore, they planned to blind the system by destroying its radars, then destroying its C^3I nodes, and finally destroying the actual missile and gun firing systems. The ground radars that provided early warning to Iraqi air defenses were first

located with great precision. In the opening round of the air war, radar sites were selectively attacked at night by Army AH-64 helicopters that flew hundreds of miles under the radars across the desert to destroy them with laser-guided *HELLFIRE* missiles, opening a corridor through the Iraqi radar for flights of Air Force aircraft that then targeted air-defense C^3I nodes to paralyze the "nervous system" of Iraqi air defenses. Homing antiradiation missiles then destroyed fire-direction and other radars. Blinded and isolated, Iraqi surface-to-air missile units were often reduced to firing their weapons as free-flight, unguided rockets.

Decapitated, the Iraqi air-defense system was not able to defend itself effectively against cruise missiles and fighter-bombers with laser-guided bombs that cut safe corridors through to key C^3I elements, nuclear, biological, and chemical warfare facilities, airfields, and other critical targets. Flying along these safe corridors, fighter-bombers then systematically destroyed these targets with precision weapons. The ability to see the air battlefield provided by the Air Force's Airborne Warning and Control System (AWACS) aircraft made it possible to control this air battle effectively. With up to 2,000 aircraft per day flying around the battlefield at all speeds and altitudes—under all visibility conditions—this task was incredibly difficult but absolutely essential. The number of midair collisions—zero—attests to its effectiveness. As the air campaign proceeded to the preparation of the battlefield phase that targeted Iraqi ground forces, another battlefield visibility system, Joint Surveillance and Target Acquisition Radar System (JSTARS), proved its worth as a tremendous combat multiplier. Still under development, JSTARS uses a special synthetic aperture side-looking radar mounted in a Boeing 707 aircraft to detect ground targets. The radar display also can be "downlinked" to multiple ground terminals at different tactical headquarters, literally providing ground commanders a consistent, real-time, "God's eye" view of the battlefield.

JSTARS had made its debut only a few months before during a major field exercise in Germany. According to open press reports, its radar "picture" of the battlefield was so perfect that it was possible to identify the wreck of a C-5A at Rhein Main Air

Base from a distance of 60-100 kms (37-62 miles). The JSTARS capability so impressed senior Army commanders that they insisted the two available developmental aircraft be deployed to the Gulf. Battlefield visibility provided by JSTARS greatly multiplied the effect of air power on the tactical battle. In the past, some reconnaissance means had been necessary to identify enemy forces not in contact with friendly forces. This intelligence was then processed, and a mission was developed to strike the enemy force. Hours elapsed, and the strike aircraft often had to find a target that may have moved many kilometers. With JSTARS, enemy forces could be identified immediately as they moved out of their assembly areas, and airborne attack helicopters or fighter-bombers could be vectored directly to attack them. Although JSTARS performance data undoubtedly will remain classified for some time to come, it clearly has the potential to do for the air-ground battle what AWACS did for the air-air battle—provide unprecedented battlefield visibility.

The picture of the air war presented thus far correlates nicely with the precision-warfare paradigm. Our mental image of the air war is very much one of cleverly camouflaged targets being unmasked by omniscient intelligence systems and destroyed by precision-guided munitions.

While this image is generally true, statistics show that the "old" firepower and shock-action paradigm was still with us. Of the vast tonnage of bombs dropped, only about 10 percent were guided munitions. The rest were standard "dumb" iron bombs, mostly dropped by B-52s hitting area targets, such as assembly areas of the Republican Guards. While the effectiveness of this area bombing is still being evaluated, even massive and repeated area bombing clearly was not as effective as desired against units that were dug in and well dispersed. In fact, the media reported that some consideration was given to loading B-52s with "smart" bombs and using F-111s to guide the bombs to their targets. (B-52s aren't equipped with laser-guidance systems.)

The point here is that the small percentage of guided munitions probably contributed disproportionately to the effectiveness of the air-to-ground war. In the future, the Air Force will have to decide if it makes good sense to increase the proportion of guided munitions.

Ground War. The air war lasted almost 40 days—the *ground war* ran only 100 hours. Consequently, information on the ground campaign is more sketchy and harder to come by. However, the ground war also showed evidence of mixed paradigms. The old firepower and shock action paradigm was clearly alive and well—and for good reasons. We had the time and resources to fight a rich man's war, a war of massed materiel that the US Army has favored since the Civil War. With no reason to accept the risk of having too little, we brought in as much as we could, including an entire heavy armored corps from Europe and hundreds of thousands of troops from the United States. Ammunition dumps with hundreds of thousands of tons of ammunition covered thousands of acres. We had plenty of firepower and shock action. Then we had to ship it all back.

With hindsight, it's possible to say that our application of the new, precision-warfare paradigm—together with all our other advantages—led to a surprisingly swift victory and made much of this massive buildup redundant. Most of our commanders clearly understood how to exploit our ability to see the battlefield—to collect, analyze, and disseminate battlefield information—to optimize our use of the new battlefield lethality while neutralizing Iraq's ability to use it against us.

A brief analysis of ground operations bears out this truth. Faced with a classic Iraqi defense in depth (almost a carbon copy of its defenses during the Iran-Iraq War) along the Kuwait-Saudi border, CENTCOM opted to envelop the defense by going around its western flank and penetrating to the Euphrates River, cutting off Iraqi forces in Kuwait, where they could be destroyed in detail. Command of battlefield information was critical. During the battlefield preparation phase preceding the ground operation, CENTCOM concentrated on destroying Iraqi's C^3I. Recognizing Saddam Hussein's totally centralized control, CENTCOM attacked Saddam Hussein's ability to talk with his forces and to see the battlefield. Using extensive operational security procedures, CENTCOM then performed the Herculean logistical task of moving two full corps to the western flank, where they could drive around the bulk of the Iraqi defense. Apparently, this massive operation was successfully concealed from the Iraqis—at least they were not able to reposition forces to oppose it.

Because US forces had been designed for the relatively short operational distances in Europe, they were logistically unprepared for the much greater operational distances in the Gulf. The M1 tank, for example, has great speed and tactical mobility because of its turbine engine, but it's a real "gas guzzler." To provide the required operational mobility, CENTCOM brought in hundreds of high-mobility fuel tankers for the armored and air-assault divisions, providing operational mobility to cross hundreds of kilometers of desert to reach the Euphrates.

Where it was necessary to break through Iraq's prepared defenses, the Allies used air support (with many precision munitions) and highly accurate artillery fire (sometimes with *COPPERHEAD* precision munitions) to destroy Iraqi C^3I elements, their berms, and even their minefields and flame trenches. With their ability to see the battlefield destroyed, the Iraqis were not able to attack Allied forces preparing to breach the defenses. After quickly breaching minefields and berms with mechanical and explosive breaching devices, the Allies proceeded to penetrate the depth of the defense and attack the Iraqi center of gravity, the Republican Guard divisions. In this fight, Army forces, covered by a screen of AH-64 attack helicopters and OH-58D observation helicopters[51] and provided with JSTARS downlinks, had an unprecedented ability to see the battlefield. They obtained the best advantage from their superior night-weapon sights by attacking at night or during poor visibility—Iraqi prisoners often reported that their tanks blew up before they even knew American forces were in the area. In many cases, counterattacking Republican Guard forces were destroyed by AH-64s and air support vectored by OH-58Ds or JSTARS before they could engage American ground forces.

Army forces were able to fight this way because of their ability to see the battlefield, particularly by knowing where their own forces were. These battles involved moving thousands of vehicles and helicopters across hundreds of kilometers of trackless desert—at night or in bad weather—without killing each other. Several pieces of technology made this feasible. First, tactical satellite communications down to brigade level made it possible to communicate reliably across hundreds of kilometers. Second, thousands of Global Positioning System (GPS)[52]

devices allowed columns to navigate and call fires precisely across featureless desert. Highly reliable navigation and communications allowed US commanders to know where their units were at all times.

In sum, US commanders in the Gulf not only understood the precision-warfare paradigm—implicitly if not explicitly—but they also had the wherewithal to exploit it. Conversely, a strong argument can be made that their precision-warfare paradigm allowed them to optimize the advantages of their new technologies.

Battle of the Paradigms? So there we have it—Saddam Hussein's World War I-vintage paradigm stacked up against American precision warfare. But was "paradigm superiority" decisive? Probably not, given all the other overwhelming Allied advantages, but it did make a major difference. Precision warfare probably turned what might have been "only" a spectacular victory into one of epic proportions. If nothing else, the superiority of the American paradigm certainly helps to explain the speed of the Allied victory and the disparity between anticipated losses and actual Allied losses, which were well below our wildest hopes and most fervent prayers.

LESSONS LEARNED

The Gulf War was really the first time we put together all factors allowing us to exploit the precision-warfare paradigm. Doctrine, equipment, training, leadership—all came together at the right time and place. However, like the first time in anything, things were not perfect. Many things were patched together quickly. Absolutely essential capabilities (such as GPS) were bought and fielded as quickly as possible. Developmental items years away from production by peacetime standards, like JSTARS, were rushed to the Gulf. Thus, it is useful to look at a few shortcomings that need fixing before we can exploit precision warfare well.

Identification, Friend or Foe (IFF). We learned in the Gulf that precision warfare requires units to operate in small elements, often intermingled with the enemy. We also learned that

precision weapons hit and kill precisely what they're fired at, friend or foe.

Unfortunately, through our wonderful thermal (and other) sights, enemy white blobs look very much like friendly white blobs—visual-target recognition becomes impossible at the extreme ranges at which it is now possible to hit targets. Consequently, we took too many casualties from fratricide (friendly fire) on the ground. Conversely, no cases of air-air fratricide were reported, mostly because aircraft are all equipped with devices that identify them as friendly on friendly radar scopes. Clearly, we need to do something similar for ground forces.

Stealth on the Ground. We need to keep in mind that we operated in an environment in which battlefield visibility was almost completely denied to the Iraqis. If they had had anything near our ability to see the battlefield, casualties might have been much higher.

The war showed just how vulnerable ground-combat systems are to detection and destruction, particularly from the air. It also showed how valuable "invisibility" is to aircraft, like the F-117A "Stealth Fighter." If we are going to avoid the lethality of the next battlefield, we need to investigate application of "low observable" (that is, "stealth") technologies for our ground-combat systems. In the future, the ability to avoid detection may be more critical to survival than speed, maneuverability, or armor protection.

Intelligence. If precision warfare is predicated on the ability to collect, analyze, and disseminate battlefield information, we clearly need a few fixes. We do a great job of collection, but our ability to analyze and disseminate leaves something to be desired. Solutions lie both in technological applications and in policy.

Policy should be the easiest to fix, but it probably won't be. The problem lies in our logical desire to keep our intelligence-gathering capabilities as secret as possible, leading to a centralized approach to analysis and dissemination. Consequently, national-level intelligence (intelligence produced by national-level intelligence gathering means, like satellites) is analyzed centrally, then disseminated to operational and tactical

commanders. But this process takes time, and the accuracy of tactical intelligence can decline in proportion to the square of the time it takes to get to the user, especially in maneuver warfare. That is, if an enemy unit can move one "square" an hour, it can be in any of 4 squares at the end of 1 hour, in any of 16 squares at the end of 2, and in any of 36 squares at the end of 3. Thus, when divisions are moving hundreds of kilometers in a few days, intelligence even a few hours old can be worthless.

The solution is a policy that allows national-level intelligence to go directly to tactical users, even if they have to do their own analysis. While this solution sounds simple, it may prove very difficult to balance security needs of very expensive, highly classified capabilities with the need to provide timely information to tactical users whose capture would compromise the intelligence-gathering capability.

Two twin problems in analysis and dissemination lend themselves to technological solutions. We now collect more intelligence than we can *analyze* and *route* to users manually. With tremendous advances in computer technology, it should be possible to develop artificial intelligence systems to aid in these two critical tasks.

Space. Some wise people have said that the Gulf War was truly the first space war. Space-based systems played critical roles in intelligence-gathering, communications, and navigation. These roles were absolutely vital, in that none of these critical functions could have been done very effectively without space-based systems. In a nutshell, we have become dependent on space.

We clearly used space to our great advantage, but we did so in an absolutely benign environment. Space support has become so important to US forces that it may be a vulnerable center of gravity open to enemy attack. We would do well to figure out how to operate in situations in which our vital space assets are vulnerable to attack. The bottom line is that space support is so critical and defense of space assets so vital that no future commander should attempt to develop a ground-campaign plan without concurrently developing a supporting space-campaign plan.

THE ROAD AHEAD

The magnitude of our victory in the Gulf should provide the "spark of understanding" that allows us to explicitly adopt precision warfare as our operative warfighting paradigm. Historically, however, success can breed resistance to change. It is indeed possible that the coming years of fiscal retrenchment and lack of a truly global military threat will lead to complacency, as happened in the western democracies after World War I. Our great victory in the Gulf may lead us to believe that we've got it all absolutely right, why should we change anything?

This complacency would leave us essentially where we are today—caught between the "old" firepower-shock-action paradigm and the "new" precision-warfare paradigm: we may never develop a full appreciation for the power of the new paradigm—we may be left with a half-jelled understanding of what it can really do.

We mustn't forget that ours were not the only eyes that watched the Gulf War. Others (who resemble Saddam Hussein more than they do us) also were watching, and they, too, drew conclusions. And they may not always be friendly. We cannot afford to rest on our Gulf War laurels. To retain our world leadership and to assure to our posterity the benefits of freedom and justice that our leadership guarantees, we must be prepared to defend freedom in the future as we have in the past. But we must prepare to fight not the past war but rather the war to come. And the war to come will be precision warfare.

ONE FINAL NOTE

The idea of precision warfare will conjure up images of bloodless conflict, more like a computer game than the bloody wars we've known in the past. Nothing could be further from the truth. We were lucky in the Gulf. We fought an enemy who could not even conceive of precision warfare. We won't be so lucky next time.

Warfare may have changed—its impact on nations, armies, and soldiers has not. The fates of nations and armies will still be

decided by war, perhaps more rapidly than the past. Losers may still spend generations recovering from the consequences of defeat. And soldiers will always be the key to victory. Technology and the ability to handle it may be increasingly important, but soldiers will always win or lose wars. The battlefield will always be a dangerous, frightening, and lonely place. Only soldiers of character and courage, well trained and ably led, will survive there and win—tomorrow as they have in the past.

NOTES

1. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970), p. 10.

2. Ibid., pp. 5-6.

3. Ibid., p. 68.

4. Lee McCardell, *Ill-starred General: Braddock of the Coldstream Guards* (Pittsburgh: University of Pittsburgh Press, 1958). Probably the best book on the subject, paints Braddock in a very sympathetic light. At least he had the good grace to be mortally wounded during the debacle.

5. Ibid.

6. Theodore Ropp, *War in the Modern World* (New York: Collier, 1962), p. 50.

7. John E. Jessup, Jr. & Robert W. Coakley, *A Guide to the Study and Use of Military History* (Washington, DC: US Government Printing Office, 1982), p. 161.

8. Andrew F. Krepinevich, Jr., *The Army and Vietnam* (Baltimore: The Johns Hopkins University Press, 1986), p. 5.

9. Kuhn, p. 84.

10. Russell F. Weigley, *The American Way of War: A History of United States Military Strategy and Policy* (Bloomington, Ind.: Indiana University Press, 1973), p. 135.

11. The Minie ball was an oblong bullet small enough in diameter to be dropped down a rifle barrel. The base was hollow so that the gas pressure generated by the burning powder pressed it into the rifling of the barrel. It was named after Captain Claude Etienne Minie of the Chasseurs D'Orleans of the French Army, one of the first people to suggest the principle.

12. Grady McWhiney and Perry D. Jamieson, *Attack and Die: Civil War Military Tactics and the Southern Heritage* (University, Ala.: University of Alabama Press, 1982). Essentially a quick synopsis of many of McWhiney's main points. He does an absolutely superb job of explaining *why* the Civil War was so bloody. The book is "must" reading for any serious student of the Civil War.

13. Weigley, p. 102.

14. McWhiney, p. 164.

15. Ibid., p. 19.

16. Ibid., p. 18.

17. Ropp, p. 204.

18. J.F.C. Fuller, *War and Western Civilization* (London, 1932), pp. 227-8, quoted in Ropp, p. 243.

19. Ivan S. Bloch, *The Future of War in Its Technical, Economic, and Political Relations*, trans. R.C. Long of vol. 6 of the original (Boston, 1903), pp. xxxi, lxxix, as quoted in Ropp, p. 219.

20. B.H. Liddell Hart, *The Memoirs of Captain Liddell Hart*, 2 vols (London: Cassell & Company, 1965). One of the best and most complete—if somewhat self-centered—accounts of efforts to prepare the British Army for mechanized warfare.

21. Heinz Guderian, *Panzer Leader*, trans. Constantine Fitzgibbon (New York: E.P. Dutton & Co, 1952), p. 30.

22. Gordon W. Prange, *At Dawn We Slept: The Untold Story of Pearl Harbor* (New York: McGraw-Hill, 1981), pp. 98-106. Superb, concise account of Japan's decision to move the aircraft carrier from a supporting to a leading role.

23. Erwin Rommel, *The Rommel Papers*, ed. B.H. Liddell Hart, trans. Paul Findlay (New York: Harcourt, Brace, 1953), p. 204.

24. Liddell Hart, pp. 164-65.

25. From an unpublished memorandum from the US Army VII Corps Command Sergeant Major for the Sergeant Major of the Army, subject: Lessons Learned by NCOs of VII Corps During Operation Desert Shield/Storm, dated 20 April 1991.

26. Chaim Herzog, *The War of Atonement, October, 1973* (Boston: Little, Brown and Company, 1975), p. 87.

27. Stig Lofgren, "Missiles Against Tanks and Aircraft," *International Symposium of the 1973 October War* (Cairo, Egypt, 1975), p. 103. The Israelis lost 810 tanks and armored vehicles out of the 4,700 they started the war with; Egyptians and Syrians lost 1,905 tanks and armored vehicles out of the 6,450 they started with. These figures from the International Institute for Strategic Studies are for total inventories, not for numbers actually engaged.

28. Herzog, p. 221.

29. Rommel, p. 122.

30. Liddell Hart, p. 164.

31. Based on a personal discussion with an Israeli officer who served as a brigade commander on the Golan in 1973.

32. Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War, Vol. III: The Afghan and Falklands Conflicts* (Boulder, Colo.: Westview Press, 1990), pp. 175-176.

33. Ropp, p. 220.

34. Timothy T. Lupfer, *The Dynamics of Doctrine: The Changes in German Tactical Doctrine During the First World War*, Leavenworth Papers No. 4 (Fort Leavenworth, Kans.: Combat Studies Institute, US Army Command and General Staff College, 1981). This discussion of German doctrinal development during World War I is a synopsis of Lupfer's paper—the best available analysis of doctrinal change during wartime.

35. Guderian, p. 20.

36. Ibid.

37. Ibid.

38. Ibid., p. 24.
39. Ibid., p. 30.
40. Ibid., p. 90.
41. Ibid., p. 37.
42. Rommel, p. xviii.
43. Ibid., p. 520.
44. Field Manual 100-5, *Operations* (Washington, D.C.: Headquarters, Department of the Army, 1986), pp. 14-15.
45. Discussion of requirements for each tenet of AirLand Battle doctrine is taken from a briefing prepared by Col. Richard Sinnreich, School of Advanced Military Studies, US Army Command and General Staff College, Leavenworth, Kans. in 1985.
46. David E. Fisher, *A Race on the Edge of Time: Radar—the Decisive Weapon of World War II* (New York: McGraw-Hill, 1988). A quick synopsis of Fisher's book—one of the best examples of the process by which an armed force adopts a revolutionary new technology.
47. Ibid., p. 268.
48. Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War, Vol. II: The Iran-Iraq War* (Boulder, Colo.: Westview Press, 1990), p. 133.
49. Ibid., pp. 149-150.
50. Ibid., p. 247.
51. The OH-58D, sometimes referred to as the Army Helicopter Improvement Program aircraft, has a mast-mounted Forward-Looking Infrared surveillance system that can see many kilometers—day, night, and through haze and smoke. It also can designate targets for laser-guided projectiles fired from other aircraft or artillery.
52. Notebook-sized receiving devices that use the constellation of Global Positioning System satellites to provide locations accurate to tens of meters.

ABOUT THE AUTHOR

Colonel Richard J. Dunn III, US Army, *is a combat engineer officer with extensive service in infantry divisions and on the Army Staff. He researched and wrote this paper as a Research Fellow and National War College student, National Defense University. Colonel Dunn has a B.S. from Bucknell and an M.P.A. from Harvard; he studied international relations at the National Political University of Taiwan and was the first Olmsted scholar to study in Chinese. Colonel Dunn is currently at the Pentagon preparing to assume command of a brigade in the Republic of Korea.*