Chapter Four

AN INFORMATION-BASED REVOLUTION IN MILITARY AFFAIRS*

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The world is on the cusp of an epochal shift from an industrial- to an information-based society. History demonstrates that changes of this magnitude do not occur without being accompanied by fundamental change in the way war is conducted.[1] This "Information Revolution" is a product of advances in computerized information and telecommunications technologies and related innovations in management and organizational theory.

Today, rapid and far-reaching changes are occurring in how information is collected, stored, processed, and disseminated, and in how organizations are designed to take advantage of this increased availability of information.[2] The Information Revolution is setting in motion forces that challenge the design of many institutions. It disrupts the hierarchies around which modern institutions—particularly military institutions—traditionally have been designed. It diffuses and redistributes power, often to the benefit of those that once may have been considered lesser actors. These changes will inevitably have a profound impact on the means and ends of armed conflict.[3]

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HISTORICAL CONTEXT

Following the Persian Gulf War, many authors focused on the impressive array of high-technology weapons that allowed the U.S.-led coalition to overwhelm the world's fourth largest army in a remarkably short time. They used this conflict as evidence that a Military-Technical Revolution (MTR) had occurred.[4] Unfortunately, use of the term MTR denotes an inordinate emphasis on the importance of technology at the expense of other elements of revolutionary change.[5] For this reason, revolution in military affairs (RMA) is the preferable term as it places the focus on the *revolution*, and implicitly assigns *technology* a supporting role.

CHARACTERISTICS OF RMAs

There are, by definition, significant differences between evolutionary and revolutionary change. In the security context, these differences can be described as follows:

> Evolution is the logical progression of an existing system or framework, while revolution connotes a fundamental break with precedent . . . . Performance improvements which signal tactical revolutions very rarely justify revolution at the operational or strategic level. A truly revolutionary strategic development alters perceptions of the relationship of means to ends and, most importantly, dictates a reformulation of warfighting doctrine—the codified precepts that govern [military] operations.[6]

Accordingly, revolutions are not merely more clever technological (or organizational) breakthroughs than ordinary evolutionary innovations; these revolutions are more profound in both their sources and implications.[7] They involve fundamental discontinuities, i.e., dramatic breaks with the existing status quo. It is important to recognize that a revolution is not simply an existential condition—i.e., created simply by the appearance of new technological capabilities. Without recognition and exploitation, both requiring positive action, there can be no revolution. Creating a revolution is, therefore, more than pushing the limits of military technology; it is an active process that requires effective adaptation by individuals and organizations for successful exploitation to occur.[8]

Implications of a revolutionary new technology are often not widely recognized at first. Frequently, organizations try to fit the innovative technology into established ways of doing things, and these innovations are expected to prove themselves in terms of existing measures of effectiveness.[9] It may take time to realize that inserting new technology into old systems and organizations may create new inefficiencies, even as some current activities become more efficient or effective. It may take even more time to realize that the activity itself—in both its operational and organizational dimensions—should be restructured, even transformed, to realize the full potential of the new technology.[10]

Truly revolutionary developments often do not merely enhance the ability to fulfill existing missions, but rather are best suited to perform new functions or meet previously unidentified requirements. Unless, however, these new functions are captured in the accepted methods of assessment, innovative developments may not *appear* to offer significant operational enhancements. Thus, as the environment is changed by revolutionary innovation, the old measures of effectiveness may no longer be appropriate to measure the new modes of operation, and may no longer be relevant to altered objectives.[11] With revolutionary military innovation, fundamental change to the existing warfighting paradigm is guaranteed.

PREVIOUS REVOLUTIONS

While the notion of periodic and fundamental change in the conduct of war is not a new one, the systematic study of technology's impact on war is a relatively recent phenomenon. Perhaps the definitive work on the subject is Martin van Creveld's *Technology and War: From 2000 B.C. to the Present*. In this book, van Creveld divides military history into four eras: the "Age of Tools," the "Age of the Machine," the "Age of Systems," and the "Age of Automation."[12] This is not to suggest that there have not been significant changes in the conduct of war *within* these eras—these certainly have occurred—but rather is intended to provide a conceptual framework for exploration of the subject.

During the "Age of Tools," which lasted until approximately 1500 A.D., most technology was driven primarily by energy from the muscles of men and animals. Following the appearance of a few basic in-

ventions (e.g., bronze and iron weapons, the stirrup, and wheeled vehicles), for the two millennia up to c. 1500 A.D. technological change had remarkably little impact on how wars were fought.

The overarching trend during the "Age of the Machine" was toward the requirement for progressively greater professional skills which led to a growing demand for harnessing military potential in an increasingly organized, even institutionalized, manner. The art of war in the "Age of the Machine" was perfected by Napoleon's France, which harnessed, for the first time, the vast resources of a newly industrializing nation to equip and support a mass army. This revolution coincided with three other significant upheavals: a political revolution that led to the rise of the republican nation-state; a socio-economic upheaval resulting from the Agricultural Revolution; and economic changes produced by the spread of the Industrial Revolution to France. The "nation in arms"—the *levée en masse*—enabled the conduct of military operations across vast distances and marked the start of a continuing trend toward the substitution of firepower mass for manpower mass in warfare.[13]

In the "Age of Systems," the emphasis shifted to the integration of technology into complex networks, with the individual elements of technology becoming integrated with the other elements, first by the railway, then the telegraph, and then through other increasingly complex technologies. This era culminated in World War II with the innovative application of mechanization, aviation, and communications technology to military use in the *Blitzkrieg*, which enabled the German army to re-introduce the strategic and operational mobility, maneuver, and initiative that were conspicuously absent from the Western Front during World War I.[14]

The importance of systems has taken a further leap forward since 1945. According to van Creveld, the unifying theme of this era is not nuclear technology, as one might expect, but rather the "Age of Automation." The real story of the post–World War II era is that ". . . the cardinal result of the invention of invention, and the accelerated pace of technological innovation, was a vast increase in the amount of information needed to 'run' any military unit, make any decision, carry out any mission, conduct any operation, campaign, or war."[15] The increase in the amount of information that must be digested for these purposes has become so overwhelming that only the automa-

tion, usually the computerization, of the information gathering and distributing process has permitted military headquarters to keep pace with the expanded volume of data.

In each of these cases, revolutionary change in the conduct of war required the introduction or maturation of new military technologies (e.g., the internal combustion engine and armor), their integration into new military systems (e.g., the tank and the intercontinental ballistic missile), the adoption of appropriate operational concepts (e.g., the armored breakthrough and strategic bombing), and, finally, the requisite organizational adaptation (e.g., the Panzer division and the Strategic Rocket Forces). Technology alone is not sufficient to produce a military revolution; how military organizations adapt and shape new technology, military systems, and operational concepts is much more important.

THE INFORMATION REVOLUTION

The Information Revolution is based primarily on significant technological advances that have increased our ability to collect vast quantities of precise data; to convert that data into intelligible information by removing extraneous "noise"; to rapidly and accurately transmit this large quantity of information; to convert this information through responsive, flexible processing into near-complete situational awareness; and, at the limit, to allow accurate predictions of the implications of decision that may be made or actions that may be taken.[16] This revolution, and the change to a post-industrial world,[17] also seems to imply significant changes not only for the means of warfare, but for its objectives as well.

The Information Revolution is also having an impact on organizations of all kinds as traditional hierarchies are increasingly being replaced by amorphous networks. While institutions are traditionally built around hierarchies and seek to act autonomously, multi-organizational networks consist of often small organizations, sub-elements of existing institutions, and even individuals that have been linked together—often on an *ad hoc* basis. The Information Revolution favors the growth of such networks by making it possible for diverse, dispersed actors to communicate, coordinate, and operate together across greater distances and on the basis of more timely and higher quality information than ever before possible.[18]

ROOTS OF THIS RMA

The desire to substitute firepower for manpower, or what General Van Fleet during the Korean War termed the desire "to expend fire and steel, not men,"[19] has been a focus of U.S. defense policy for many decades. This basic American value led ultimately to an effort to develop a new way of waging war that depended less and less on quantitative material superiority and attrition to ensure victory. Conceived in the 1970s, this approach was part of what former Secretary of Defense Harold Brown called the "offset strategy," which was based on the need to counter the overwhelming quantitative superiority of Soviet and Warsaw Pact forces in Europe. The aim was not simply to field better weapons than the Soviet Union; rather, the offset strategy was intended to give American weapons a systems advantage by supporting them on the battlefield in a manner that greatly multiplied their combat effectiveness.[20]

The Soviets recognized and appreciated the potential impact of these technological developments and the resultant change in American strategy. This appreciation was developed in concepts first put forward in the late 1970s and early 1980s in the series of papers by Soviet Marshal Nikolai V. Ogarkov, including his seminal 1982 paper.[21] Ogarkov worried about how to conduct decisive operations in the European theater, a theater that was dense with heavily-armored mechanized forces and supported by tactical and theater nuclear force on both sides. His concern was that, by the early 1980s, the U.S. may have solved its strategic problem by synthesizing new technologies, evolving military systems, operational innovation, and organizational adaptation into a *whole* that was more powerful than the parts.

The Soviet argument for a dawning RMA focused less on military hardware than on technological advances making possible qualitative transformations in conventional, non-nuclear warfare. Soviet strategists maintained that in the near future, "reconnaissance-strike complexes" would enable commanders to detect targets, then rapidly and effectively attack them at long ranges. These combinations of sensors and weapons would blur the traditional distinctions between the offense and defense and allow the conduct of war over much greater distances than ever before.[22] Ogarkov believed that, in modernizing military theory and practice, "stagnation and a delayed

'perestroika' of views . . . are fraught with the most severe consequences." Throughout the 1970s and 1980s, he lobbied persistently for a timely incorporation of these new non-nuclear technologies into the Soviet conventional military force structure.[23]

The 1991 Persian Gulf War was the prototype of this future kind of war. It was characterized by the widespread availability of precision, deep-strike delivery systems on land and aboard ships and aircraft, together with a large inventory of extremely lethal conventional munitions directed by sophisticated target-acquisition systems to designated targets under near-continuous surveillance. Soviet experts, for example, stressed repeatedly that the coalition won so quickly, and with minimal losses, because of its "overwhelming superiority in contemporary methods of warfare: in aviation, advanced conventional munitions, and means for reconnaissance, command and control, and electronic warfare."[24]

Desert Storm demonstrated that an important advantage of U.S. forces was their ability to execute complex, orchestrated, high-tempo, simultaneous, parallel operations that overwhelmed the enemy's ability to respond. This advantage was built not only on advanced sensors and advanced conventional munitions, but perhaps more importantly on forces supported by modern command, control, communications, and intelligence (C^3I) systems and technologies that allowed the U.S.-led coalition to collapse previous spatial and temporal constraints on simultaneous operations.

ELEMENTS OF THIS REVOLUTION

Advanced conventional munitions have made spectacular advances in lethality by linking near-real-time information to precision-guided weapons controlled by digital command and control systems.[25] Bombing has become so precise that weapon systems can routinely attack not just the building or the room, but "the *corner* of the room that will bring everything down—even the vent shaft that will put the bomb *inside* the shelter."[26] This may enable us to view the venerable military principle of mass from an entirely different perspective and alter the traditional relationship between the offense and the defense. A defender, equipped with these sophisticated munitions, can now inflict unacceptable casualties on an attacker before the latter

can close for battle, while a similarly equipped attacker can likewise reciprocate.[27]

The sensor revolution, which was enabled by the computerization of individual platforms and weapon systems, complements these advances in weapons lethality. An individual platform—manned or autonomous—can now detect and track individual vehicles, ships, or aircraft well beyond visual range, and provide targeting information on a near-real-time basis to long-range offensive attack systems. Additionally, these sensors are becoming fully integrated with traditional command and control systems to achieve synergies never before possible. The Airborne Warning and Control System (AWACS) and the new E-8A Joint Surveillance and Target Attack Radar System (JSTARS) aircraft, which couple high-technology sensors and communications with command personnel, are but two examples of this kind of C^3I.

In the past, military commanders have not had the C^3I capabilities to manage military forces to the limit of their potential effectiveness.[28] They have had to rely on increases in the individual components of combat power—i.e., mass, mobility, reach, and firepower—or the exploitation of an opponent's failings, to make up for these inadequacies. The associated costs were high not only in resources, but also in organizational distortions and operational constraints. What was often referred to as the "fog of war" is in reality disorder—the inability to maintain unity of action due to shortcomings in the C^3I systems.[29]

The post-modern battlefield stands to be fundamentally altered by the Information Revolution at the strategic, operational, and tactical levels (if these distinctions even remain valid). The increasing breadth and depth of the battlefield and the inexorably improving accuracy and destructiveness—and therefore lethality—of even conventional munitions have heightened the importance of C^3I to the point where dominance in this domain alone may, if exploited properly, yield consistent war-winning advantages.[30]

THE CHANGING SECURITY ENVIRONMENT

While the structural foundations of the post–World War II international system remain in place, there have been profound changes in

how this system actually functions. In addition to the dramatic increase in the number of nation-states, there has been a significant change in character of the participants in the international arena. Nation-states remain the primary actors, but increasingly international organizations such as the United Nations, the European Community, the Organization of American States, and a wide variety of other non-governmental organizations, such as Doctors without Borders, are making their presence felt on the international scene. In addition, transnational actors including the media, religious movements, terrorist groups, drug cartels, and countless others exert considerable influence in international relations. In essence, the world is organizing itself in a series of interconnected networks that, while in contact with each other, are not controlled by any traditional hierarchy. Nation-states find themselves pulled simultaneously in fundamentally opposite directions—toward *integration* by international security, trade, and social organizations and *disintegration* by subnational movements that seek to splinter the state.

Furthermore, modern (mostly Western) nations are developing post-industrial, "third wave" economies that are built on information as the fourth critical factor endowment (the others being land, labor, and capital). This trend carries at least three significant implications for the future international security environment.[31]

- This new factor endowment is dependent neither on unchangeable physical resources nor on large, fixed-capital investments that have long depreciation and pay-back periods. As a result, economic power built on this foundation can be developed far more quickly.
- This source of strength is also far more agile and adaptable, and can respond with shorter time constants to changes in the environment; it may well be capable of greater surprises.
- This factor is also more mobile and potentially more transferable; and power growing from it may be subject to greater diffusion.

Unless Mexico or Canada are suddenly transformed into aggressive regional powers, the U.S. will not, in the foreseeable future, be the direct object of aggression. Therefore, we can expect to fight in conflicts at extended distances, and, with the exception of a regional

power that develops weapons of mass destruction coupled with intercontinental delivery systems, without a direct threat to our national survival. Additionally, the collapse of the Soviet Union means that it is unlikely, in the immediate future, that we will face a new security threat of that magnitude.

It is possible that, in the future, few rational opponents will be likely to challenge, or will even be capable of challenging, the U.S. in a contest with large, multi-dimensional military forces. It is certainly conceivable, however, that a future challenger might choose to strike directly against the developing international networks that support the increasing internationalization of trade, culture, and politics. Such an adversary would seek to destroy not the military power, but rather the underlying fabric of the international system and its core values, especially if these values are fundamentally at odds with deeply held cultural, religious, or ideological beliefs.[32]

A LOOK AT THE FUTURE

Although we cannot definitively predict the precise course a future conflict might take, we can almost certainly expect a significant broadening of the extent of the battlefield with the operational tempo increasing by yet another order of magnitude to the point that the levels of war—the strategic, operational, and tactical—essentially merge. Lethal, precision-guided munitions will be able to be launched at ever-increasing ranges, often well beyond the visual range of the enemy. Smaller, combined-arms combat formations with advanced indirect- and direct-fire weapons will be able to dominate even larger areas than in the past.[33] Furthermore, surprise may become *the* decisive factor in determining both the "course and outcome" of a war; in fact, these may now be described as "a single phenomenon." As a result, the initial period may now be in effect the *only* period in future warfare.[34] Operational campaigning under these circumstances must be viewed as an integrated, seamless process in which the time constants of the individual elements are critical to the effectiveness of the overall plan.

Indeed, the analogy between this campaign paradigm to "just-in-time" operations and the older campaign model, with its pre-planning, clearly delineated phases, and reliance on reserves, to an inventory-based manufacturing process is noteworthy.[35] Inventory-

based management and production systems, which are the industrial counterparts to existing military command and control architectures, reflected the high likelihood of both information and control failures in the subsidiary production systems. To deal with these imperfections, industrial manufacturing systems use[d] time and excess resources, i.e., inventories, as the "slack variables." Not only did this require carrying large stocks of parts and in-process work, but this method of operations also often resulted in the production and maintenance of large inventories of finished products for which there was no longer a demand.[36]

The traditional military reliance on reserves and redundancy often has been the only method of hedging against operational failures—of overcoming the "fog of war"—by also using time and excess resources as the slack variables. Command and control imperfections increased reliance on pre-planning, thus forfeiting the benefits of the local situational awareness and responsiveness of subordinate commanders to unfolding developments on the battlefield. Under the old limitations on synchronization capabilities, there was no choice but to create hierarchical organizations and processes to enforce centralized direction. Even with pre-planned actions, shortcomings in the supporting information systems did not allow commanders at the top to know, much less fully understand, what was happening. This made it virtually impossible to exercise effective command and control of ongoing operations.[37]

Thus, synchronization efforts have been constrained by the availability of what has been, at best, partial information; and shortcomings tended to keep commanders below the level of "understanding." Modern C^3I systems now offer the opportunity to alter the existing command paradigm. The locus of the decisionmaking can be shifted down the command chain to those who must actually execute the overall plan. These subordinate commanders can now share in the global situational awareness provided by worldwide, near-real-time, integrated C^3I systems while at the same time retaining the benefits of local situational awareness.[38] This promises a significant advantage on the battlefield to the side that can best accomplish it.

EXPLOITING THE RMA

It is certain that careful implementation of the RMA will be needed since revolutions are, by nature of their potential for dramatic operational and organizational changes, antithetical to the cultural norms of existing bureaucratic structures. Detailed theories of innovation relating specifically to military organizations have only recently emerged, but it has long been the conventional wisdom that only catastrophic military defeat can move a military organization to embrace innovation.[39] No one experienced in dealing with military bureaucracies could possibly doubt that innovation in the military sphere is extremely difficult; however, there are many instances where military innovation was preceded by victory, not defeat. The interwar period is a case in point.[40]

Despite this, the historical tendency of military organizations has been to use new capabilities to support existing missions, and to oppose new capabilities that threaten existing missions.[41] For real innovation to occur, the doctrinal and operational implications of new capabilities must be translated by senior officers into new critical military tasks and missions for the entire organization.[42] This takes time, typically a generation or more, to effect.

ENABLING TECHNOLOGIES

The renowned British strategist, J.F.C. Fuller, argued that with each change in weapons, organizations and tactics must also change. Then a determination must be made as to the most dominant weapon around which to arrange the employment of other weapons. It is important to note that it is not necessary for the "master weapon" to be *the* decisive weapon on the battlefield. Its qualifications for mastery are found in its ability to immobilize or upset the enemy's tactics and so enable other weapons to be decisively used. In short, it sets the tactical pace.[43] The key to exploiting this revolution in military affairs will be correctly identifying what system constitutes the "master weapon" in this new era.

In future warfare, the struggle for information will play a central role, taking the place, perhaps, of the struggle for geographical position held in previous conflicts. Information superiority is emerging as a newly recognized, and more intense, area of competition. In re-

sponse to these developments, C^3I systems must be designed to provide commanders at all levels the information and communications needed to direct the dispersion or concentration of their forces and, more importantly, weapons' effects at the decisive point in time and space.

It may now be time to design the command and control system first, based on the full range of technological possibilities, and then select individual weapons systems for acquisition based upon our ability most effectively to integrate them into this C^3I system. This is not as far-fetched as it might at first seem. Throughout history, successful military organizations have based their organization and battlefield formations on existing command and control technologies. In a sense, it is the soldiers of the modern age who are out of step with history, acquiring weapons systems and platforms based principally on their mechanical capabilities, then improvising a command and control system that barely meets battlefield requirements.[44]

The ability of the U.S. to construct and amortize a global information network as the foundation of such a command and control system is the principal source of long-term advantage over potential adversaries.[45] While constructing this system will be expensive, the U.S. has already made much of the necessary research and development investment to lay the foundation for these future capabilities. Moreover, many of the important components of such a future system (e.g., the Global Positioning System, worldwide communications, surveillance and reconnaissance platforms, etc.) are already in place. It is this global C^3I system that will be the master weapon of the twenty-first century.

C^3I systems by themselves, however, do not fight and win wars. The weapons of tomorrow must be designed to take advantage of the possibilities offered by this global system. In fact, the era of precision-strike weapons systems that require both absolute (i.e., latitude and longitude) and relative (i.e., bearing, range, course, and speed) positioning information has already arrived.[46]

An important feature of this RMA is that the supporting technologies are the same as those being rapidly developed in the commercial world. Thus, this revolution can be based on technologies that are also critical for our success and comparative advantage in the global

economy. A sound national security investment strategy would focus resources not only on the acquisition of a small number of large-scale, global systems or networks to provide surveillance and targeting information, but also on inexpensive weapons that can be directed by this system. These investments would provide both a significant operational advantage during the short-term, and a flexible foundation on which to build for longer-term, but uncertain security challenges.[47]

HUMAN FACTORS

The primary impact of the Information Revolution is to push the envelope of the decision-making speed-limit, i.e., the speed of thought. The result of these technological advances is that the time required to take action on the battlefield is becoming increasingly limited by the speed at which the human in the loop can make a tactical decision.[48]

In the past, decisions were made at a given command level because only that level had the requisite information to make the appropriate decision. But now, everyone in the chain of command can have access to the same information at essentially the same time. This has important consequences, for both good and ill. Now the President can select bombing targets in North Vietnam and direct helicopters in Iran from the White House, or he may sleep through the night while Libya is bombed. A commander now has to know when to give an order and when to hang up the telephone and let the organization execute the plan he has devised.[49] For action-oriented people, as senior military officers often are, the decision to do nothing is often the hardest to make.

IMPACT ON ORGANIZATIONS

The future shape of military organizations was glimpsed in the 1991 Persian Gulf War. The dependence of modern military organizations on tremendous amounts of information, and the relative ease with which communications technology can disseminate that information, meant that supporting authority would inevitably diffuse out of theater of operations. Now, commanders can tap the expertise of large staffs and other organizations thousands of miles away to for-

mulate plans for actions to be taken during the next several hours. Central Command's formal organizational scheme did not explicitly acknowledge this, but the command system rapidly became dependent on informal, *ad hoc* arrangements.[50] This was not an aberration, but is representative of a trend that will only accelerate in the future.

This trend should not be resisted, but rather embraced and leveraged to our advantage. Implementing this information-based RMA will require that capabilities for the command and control of simultaneous, continuous operations be increased and that the current distinctions between these types of operations be eliminated. Moreover, shortening the time-constants for decision and action will require the decentralization of command authority, and a concomitant relaxation of control downward from top of the command pyramid. Many of the innovations portended by the Information Revolution are already reflected in changes in the organizational structures and decision processes found in the commercial sector, including changes in the role of management and the locus of decision-making in commercial organizations. These changes are intended to dramatically improve the speed of both decision and execution, which are increasingly viewed as the key elements of competitive advantage.[51]

Waging war in the post-modern era will require major innovations in organizational design, in particular a shift from hierarchical to network structures. The traditional reliance on hierarchical designs must be replaced with network-oriented models to allow greater flexibility, lateral connectivity, and teamwork across institutional boundaries.[52] In light of both the reduced costs of information gathering and distribution and the resultant increase in the capability to disseminate real-time information to dispersed consumers, we must rethink the current organizational structures designed under the old span-of-control and information processing constraints. Organizational concepts for increasing combat power that demanded massing and concentration of forces will have to be examined in light of the new opportunities to combine and synchronize disparate elements at low frictional costs; the commercial sector concept of the "virtual corporation" has obvious parallels for this military restructuring.[53]

Beyond these command and control issues, the rapidly expanding operational capabilities of military forces are also challenging the traditional division of labor—the "roles and missions"—of the military services. The further that surveillance and reconnaissance systems can see and weapons systems can shoot, the greater the zone of influence—and interest—of the commanders that control them. The result is that service-specific "battlespaces" increasingly intersect with each other, and will eventually merge.[54] The coming changes cannot help but have a significant impact on the current organizational paradigm.

CONCLUSION

Previous revolutions in military affairs have primarily served to enhance the combat power of military forces by improving the effectiveness of its constituent elements, i.e., mass, mobility, reach, and firepower. Although today's Information Revolution is not a revolution in military affairs, *per se*, it is the foundation on which one can be built. The current RMA results not from the quantity or even quality of information in and of itself, but rather from a combined revolution in higher order cognitive processes and command and control capabilities. As Desert Storm so vividly demonstrated, this revolution promises (or threatens, depending on your point of view) to restore the capacity to achieve decisive results on the battlefield, the Clausewitzian *coup de main*, and to do so in a remarkably short period time.

Fortunately, the U.S. is well-positioned to take advantage of this revolution; its constituent elements are our greatest comparative strengths. As noted earlier, the U.S. is the only nation with the ability to construct and amortize a truly global information network. Such a network can provide the foundation for a significant comparative advantage over potential adversaries for many years to come. To reiterate J.F.C. Fuller's observation, it is around this "master weapon" that we should "arrange for the cooperation of all other weapons." This is not to suggest that traditional elements of military power are now obsolete. We must continue to be prepared to deal with lower-technology challenges of the variety that have historically given us the greatest difficulty.[55]

The coming changes mirror those taking place in the commercial sector as the economic paradigm shifts from the traditional, hierarchical corporation to amorphous networks of cooperative workgroups and even individuals. The blurring of distinctions between management and labor, "physical" and "intellectual" capital, and foreign and domestic markets in the economic sphere parallels the blurring of distinctions between offense and defense and the collapsing of the strategic, operational and tactical levels in the military sphere. Profound changes are taking place that will significantly alter the way we prepare for and wage war. We would be well advised to anticipate these changes and leverage them to our advantage to preserve our security in a dangerous, unpredictable world.

NOTES

[1]As Secretary of Defense William Perry noted on May 5, 1994: "We live in an age that is driven by information. It's an age which Alvin Toffler has called the Third Wave. The ability to acquire and communicate huge volumes of information in real time, the computing power to analyze this information quickly, and the control systems to pass this analysis to multiple users simultaneously—these are the technological breakthroughs that are changing the face of war and how we prepare for war." Quoted in "Information Warfare," Office of the Assistant Secretary of Defense (C^3I) (Washington, DC, July 1994), p. 4A.

[2]"Information is becoming a strategic resource that may prove as valuable and influential in the post-industrial era as capital and labor have been in the preceding industrial age." John Arquilla and David Ronfeldt, "Cyberwar is Coming" (Santa Monica, CA: RAND 1992), p. 2. This article also appeared in the April–June 1993 issue of *Comparative Strategy*.

[3]Particularly with regard to the "exceptional lethality gained by linking real-time information to precision-guided weapons and controlling them with digital command and control." Lt. Col. Thomas X. Hammes, USMC, "The Evolution of War: The Fourth Generation," *Marine Corps Gazette*, September 1994, p. 35.

[4]See, for example, Michael J. Mazarr, et al., *The Military Technical Revolution: A Structural Framework* (Washington, DC: Center for Strategic and International Studies, 1993).

[5]RMAs are intrinsically complex phenomena, i.e., more than just new technology. One view holds that they are made up of four component elements: "operational innovation, organizational adaptation, evolving military systems, as well as emerging technologies." Jeffrey R. Cooper, "Another View of the Revolution in Military Affairs" (Arlington, VA: SRS Technologies, June 1993), p. 21. Unpublished manuscript; cited with permission of the author.

[6]Lt. Leo S. Mackay, Jr., USN, "Naval Aviation, Information, and the Future," *Naval War College Review*, Spring 1992, p. 7.

[7]This adaptation and exploitation is particularly difficult for large, bureaucratic institutions since revolutions are, by nature of the extensive organizational and opera-

tional changes involved, antithetical to existing cultural norms and bureaucratic structures. Cooper, "Another View of the Revolution in Military Affairs," p. 23.

[8]Ibid., p. 23.

[9]Arquilla and Ronfeldt, "Cyberwar is Coming," p. 18.

[10]"Changes in tactics have not only taken place after changes in weapons . . . but the interval between such changes has been unduly long. It can be remedied only by a candid recognition of each change. . . . History shows that it is vain to hope that military men generally will be at pains to do this, but that the one who does will go into battle with a great advantage—a lesson in itself of no mean value." Alfred Thayer Mahan, *The Influence of Sea Power Upon History, 1660–1783* (New York: Hill and Wang, 1957), p. 8.

[11]"For example, if an RMA involves a fundamental shift from an attrition paradigm to one in which speed of execution is as important, then it should follow that the dimension of measurement should shift as well from questions of 'how many killed' to 'how quickly'." Cooper, "Another View of the Revolution in Military Affairs," p. 24.

[12]Martin van Creveld, *Technology and War: From 2000 B.C. to the Present* (New York: Free Press, 1989). This is by no means the only conceptual framework that has been proposed. See, e.g., William S. Lind et al., "The Changing Face of War: Into the Fourth Generation," *Military Review*, October 1989; and Robert J. Bunker, "The Transition to Fourth Epoch War," *Marine Corps Gazette*, September 1994.

[13]The ultimate result of this military revolution was no less important; it provided not just the ability to "conquer a *neighbor*, but to seize a *continent*—or in more modern terms, the means to wage a *theater-wide* campaign." Cooper, "Another View of the Revolution in Military Affairs," pp. 15–16. Emphasis in original.

[14]While the French and British calculated the speed of a combined-arms unit by that of its slowest element, the Germans measured it by that of the fastest—the tank—and insisted that their Panzer divisions move as rapidly as possible. Lt. Col. Douglas A. MacGregor, USA, "Future Battle: The Merging Levels of War," *Parameters*, Winter 1992–93, p. 36.

[15]Van Creveld, *Technology and War*, pp. 235–236.

[16]Jeffrey R. Cooper, "The Coherent Battlefield—Removing the 'Fog of War': A Framework for Understanding an MTR of the Information Age" (Arlington, VA: SRS Technologies, June 1993), p. 23. Unpublished manuscript; cited with permission of the author.

[17]See, for example, Alvin and Heidi Toffler, *The Third Wave* (New York: Morrow Press, 1980).

[18]Arquilla and Ronfeldt, "Cyberwar is Coming," pp. 3–4.

[19]General James A. Van Fleet, USA, quoted in Bernard Brodie, *War and Politics* (New York: MacMillan Press, 1973), p. 91.

[20]William J. Perry, "Desert Storm and Deterrence," *Foreign Affairs*, Fall 1991, pp. 68–69.

[21]Marshal Nikolai V. Ogarkov, "Always in Readiness for the Defense of the Fatherland," *Voyenizdat*, 1982.

[22]Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, DC: 1993), p. 237.

[23]Mary C. FitzGerald, "The Soviet Military and the New 'Technological Operation' in the Gulf," *Naval War College Review*, Autumn 1991, p. 17.

[24]Ibid., p. 15.

[25]In fact, some have speculated that those capable of producing such weapons will dominate warfare to a degree not seen since Western Europeans conquered and colonized most of the known world. Hammes, "The Evolution of War," p. 35.

[26]Lt. Col. Edward Mann, USAF, "One Target, One Bomb: Is the Principle of Mass Dead?" *Military Review*, September 1993, p. 37. Emphasis in original.

[27]Lt. Col. Lester W. Grau, USA, "In the Wake of Revolution, Continuity and Change: A Soviet General Staff View of Future Theater War," *Military Review*, December 1991, p. 11.

[28]"From Plato to NATO, the history of command in war essentially consists of an endless quest for certainty . . . ." Martin van Creveld, *Command in War* (Cambridge, MA: Harvard Press, 1985), p. 264.

[29]Cooper, "The Coherent Battlefield," pp. 1–2.

[30]Arquilla and Ronfeldt, "Cyberwar is Coming," p. 7.

[31]Cooper, "Another View of the Revolution in Military Affairs," p. 19.

[32]Ibid., pp. 13–14. The Bosnian Serbs appear to be following such a strategy.

[33]Chris Bellamy, *The Future of Land Warfare* (New York: St. Martin's Press, 1987), pp. 298–299.

[34]FitzGerald, "The Soviet Military," p. 38.

[35]Cooper, "Another View of the Revolution in Military Affairs," p. 38.

[36]"The old-style Soviet central planning with huge stocks of unwanted merchandise was the ultimate example of this paradigm." Cooper, "The Coherent Battlefield" p. 26.

[37]Ibid., p. 19.

[38]Ibid., p. 19.

[39]"Armies are more often ruined by dogmas springing from their former successes than by the skill of their opponents." J.F.C. Fuller, "The Tactics of Penetration," *The Journal of the Royal United Service Institution*, November 1914, p. 389. Quoted in Maj. Anthony M. Coroalles, USA, "The Master Weapon: The Tactical Thought of J.F.C. Fuller Applied to Future War," *Military Review*, January 1991.

[40]The Marine Corps' development of amphibious doctrine and techniques in the interwar years, despite the example of Gallipoli during World War I, is one such example.

[41]See Bruce Gudmundsson, "The Multiple Launch Rocket System: On Time and Under Budget," Kennedy School Case Program C16-87-773.0, Harvard University, 1987, for an excellent example of this phenomenon.

[42]Stephen Peter Rosen, "New Ways of War: Understanding Military Innovation," *International Security*, Summer 1988, p. 136.

[43]J.F.C. Fuller, "A Study of Mobility in the American Civil War," *Army Quarterly*, January 1935, p. 271. Quoted in Coroalles, "The Master Weapon."

[44]The Romans, for example, made exactly this sort of decision when they chose to rely primarily on highly disciplined infantry forces instead of uncontrollable masses of cavalry. A millennium later, the hugely successful Mongols designed their cavalry

formations specifically to facilitate control in battle. Maj. Ralph Peters, USA, "The Movable Fortress: Warfare in the 21st Century," *Military Review*, June 1993, p. 66.

[45]Cooper, "The Coherent Battlefield," pp. 33–34.

[46]"In Desert Storm, the effective employment of precision systems such as the F-117/GBU-27 combination required correspondingly precise target information, whereas the areas in which the strategic portion of the air campaign was least effective were precisely those in which fundamental gaps in Coalition understanding of entire target systems existed." Keaney and Cohen, *Gulf War Air Power Survey*, p. 248.

[47]Cooper, "The Coherent Battlefield," pp. 40–41.

[48]As both the *U.S.S. Stark* and *Vincennes* incidents demonstrated, in the age of "information overload" the slowest component in the tactical chain of command is often the human making the decision of whether or not to shoot.

[49]"In a sense, General Norman Schwarzkopf's brilliance in Desert Storm was in knowing when to be quiet." Captain John W. Bodnar, USNR, "The Military Technical Revolution: From Hardware to Information," *Naval War College Review*, Summer 1993, p. 19.

[50]Officers in the basement of the Pentagon helped pick targets and plan attacks; staffs at Langley Air Force Base in Virginia managed CENTAF's spare parts accounts; Space Command provided warning of missile attacks against Israel and Saudi Arabia; and meteorologists processed weather information for use within the theater. Keaney and Cohen, *Gulf War Air Power Survey*, p. 248.

[51]Cooper, "Another View of the Revolution in Military Affairs," p. 36.

[52]"Most adversaries that the United States and its allies face in the realms of low-intensity conflict—international terrorists, guerrilla insurgents, drug cartels, ethnic factions, etc.—are all organized like networks (although their leadership may be quite hierarchical). Perhaps a reason that military (and police) institutions keep having difficulty engaging in low-intensity conflicts is because they are not meant to be fought by institutions." Arquilla and Ronfeldt, "Cyberwar is Coming," pp. 17 and 23.

[53]Cooper, "The Coherent Battlefield," pp. 34–35.

[54]To cite just a few examples, Navy, Marine Corps, and Air Force aircraft now use the same Air Tasking Order; data collected by Air Force surveillance aircraft guides the movement of Army formations; long-range Army missiles strike deep targets while Air Force aircraft engage enemy vehicles in contact with friendly forces; and national sensors alert anti-tactical ballistic missile forces of missile launches. Martin C. Lybicki and CDR James A. Hazlett, USN, "Do We Need an Information Corps?" *Joint Forces Quarterly*, Autumn 1993, p. 89.

[55]"While games can be nice while they last, in our age too there is a real danger that they will be upset by barbarians who, refusing to abide by the rules, pick up the playing-board and use it to smash the opponent's head." Van Creveld, *Technology and War*, p. 296.