U.S. Air Force (Jeffrey Allen)

The Second REVOLUTION

By JAMES STAVRIDIS

FIRST PRIZE 96 REVOLUTION IN MILITARY AFFAIRS

A paradox is emerging as the revolution in military affairs (RMA) moves ahead: the larger the magnitude of the revolution, the greater the possible long-term advantage to a potential enemy. Why? The answer lies in the second revolution.

The system of systems—a complete architecture of detection, selection, display, targeting, and attack—will revolutionize war. Related advances in information warfare will complement and enhance the progress made in the first revolution. We will adjust and integrate these developments with new organizations, doctrine, and tactics, techniques, and procedures, many of which will be integrated into the Armed Forces by early in the next century, and other industrialized nations will gradually follow suit. Indeed, some components are already entering service, and others are being aggressively purchased, programmed, and

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researched. Both doctrine and operational concepts are undergoing study and change. *Joint Vision 2010* makes it clear that we are on the leading edge of this first revolution, evolving the military

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for a "challenging and uncertain future." We are moving into the first revolution.

But throughout military history—in fact, all of human history—for every action there has been a reaction, often stronger and usually more important. In military science this is translated into *offensive* and *defensive* weapons, tactics, and systems of war. At other times it is manifested in a revolution brought about by a sudden technological advance. Stone was superseded by iron and bronze as the materials of offensive weaponry; and fortifications were improved in response. Then came the rise of organized armies and the warrior on horseback as a weapons system until the cannon and gunpowder changed everything. Firepower improved, with revolutionary jumps such as the rifle, machine gun, and tank. The great defensive barriers of the early 20th century were countered by *Blitzkrieg*, the massive armored battleship was overtaken by carrier airpower, and one day the lethal ballistic missile may be rendered ineffective by a new defensive system.

While this analogy is not precise, it is possible to think of the journey of RMA from now to the early part of the next century as consisting of two distinct revolutions. The tide of the first is rising today and will crest shortly after the turn of the century. It is characterized by the system of systems, information warfare, dominant knowledge, precision weapons, sophisticated processing, display capabilities, low observables, smaller dispersed forces, and massed weapons effects.

The second revolution will likely be different. By watching the first revolution, an enemy may be in a position to "skim the cream" of its advancements while simultaneously moving into the second revolution. It may thus obtain much of the technology at substantially lower cost after the expensive researching, prototyping, and fielding are complete. That is the essence of the paradox: if the current revolution really is a radical process requiring major investment and an expensive and extensive force restructuring, we may be left with fewer resources to pursue a second revolution. The result may be a very expensive, highly capable, but distinctly first revolution force structure.

An enemy may have more efficiently moved on to a second revolution, taking advantage of our efforts to develop and field the first set of systems—because much of the technology involved in the first revolution is commercially applicable, dual use in character, and widely available—from the Internet to the classroom. We must never completely base our strategy on something that we cannot control; and the lesson to be drawn from interaction with technology is that the experience is far from controllable. We must recognize that actions today will drive participation in, and actually permit the execution of, the first revolution. But even as we pursue the first series of advances, we must consider and plan for the inevitable reaction—the second revolution.

The First Revolution

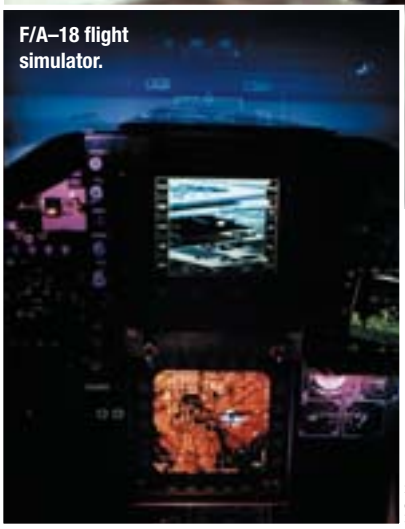
It is generally accepted that the first RMA proffers three key instruments of national power. The first is the *system of systems,* shorthand for the vast collective synergy achieved by melding formerly disparate means to establish battlespace awareness, command and control, and precision force.[1] Second and equally important is *extended information dominance*, the means to control bitstreams in the increasingly interdependent global information network. The third instrument—a corollary of the first—is known as *information warfare*, which can be defined as the capability to disrupt or override enemy information systems while defending one's own.[2]

The system of systems has received most of the attention in the RMA debate. It is marked by technologies, tactics, and organizations that allow for accurate wide-area scouting (unmanned aerial and undersea vehicles, overhead sensors, Aegis radars, JSTARS aircraft, acoustic sensors); essentially instantaneous data fusion (global command and control system, C^4I for the warrior, linked combat centers); and precision massed fires (precision guided munitions, long-range strike, enhanced effect weapons). Combining these systems, the first revolution will provide dominant battlespace knowledge and the ability to take full advantage of it—dissipating if not eliminating the fog of war.[3]

Applying extended information dominance through "bitstreams" is a second characteristic that many associate with the first RMA. Providing information—instead of military capital stocks and troops—could enable us to better execute alliance obligations, undertake stand-off operations, and realize greater combat efficiencies. For instance, we could furnish both target information and surveillance through bitstreams to allies, who could then leverage their systems far more effectively in a region, such as by launching precision

Simulated aerial chemical attack, Roving Sands '97.

1st Combat Camera Squadron (James D. Mossman)



F/A–18 flight simulator.

U.S. Navy

strikes or conducting peace operations based on distant surveillance systems.

Information warfare, also referred to as hacker warfare or cyber warfare (or commercially as information assurance), is the third emerging instrument. As national systems—from banking to electric power and communication—become increasingly dependent on computer networks, a huge vulnerability arises. "Digi-criminals are already having a great time . . . the outlook for protection is bleak."[4] By using advanced software to attack enemy information systems, great advantages can accrue to the state or transnational actor best positioned for cyber warfare. Access may directly come from satellite broadcast via integrated computer networks, or the Internet itself. This could become the guerrilla warfare of the future.

Combined, these technologies comprise the first RMA: "a new paradigm of warfare, based not on attrition, but on the ability to paralyze and shock."[5] These approaches and technologies will indeed revolutionize warfare by early in the next century.

Adversarial Reaction

While initially costly to research, develop, and field, many of the technologies of the first revolution will quickly become accessible. This is due to the extensive applicability of commercial technology inherent in the revolution. A potential enemy could recognize this fact and be able—with relative ease—to incorporate these rapidly disseminating elements of the first RMA into its force structure. "The low cost of many information age technologies will help potential adversaries improve their military capabilities as they learn to leverage these technologies effectively."[6]

Both extended information dominance and information warfare will stem from computers. The knowledge that drives their implementation will be widely available on the Internet, through commercial publications, and by study at American and other Western institutions. Of particular significance will be access to display systems to fuse and organize information for easy access in smaller units—essentially the function of commercial information systems. Accelerating diffusion of

these technologies will be a prime element in the strategic construct early in the 21st century.

Likewise the system of systems, although large and complex, is intelligible and applicable to an enemy through its component parts: "The larger the system, the smaller and more powerful the important individual parts."[7] But an enemy would be left with the problem of countering these portions of the first RMA that are too expensive for them to acquire. This could lead to an endless cycle in warfare: an enemy discovers ways to fuse what it can afford from the *first* revolution with new ideas, technologies, and concepts—thus creating a *second* revolution in military affairs.

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The Second Revolution

Although it is difficult to identify all the systems that will survive and become central to the first RMA, it is evident that precision weapons, advanced sensors, low observables, sophisticated networks, and information systems will predominate. The challenge is to determine what might be central to a second revolution. One approach to this problem is to examine the broad categories of technology and military-science application in the first revolution and then seek counters to them. It is also important to identify areas of study that may be under-represented in the first revolution. Looking at counters to the first RMA is particularly instructive and will probably provide the best point of departure (see the accompanying figure which lists points and counterpoints).

First, an enemy would seek to place many key command and control nodes underground. They would be joined through hardened or buried connectivity links. Other nodes would probably be located at sites that are politically difficult to attack such as hospitals, schools, and marketplaces. Their nodes would also be small and highly dispersed across large areas, perhaps in kiosks located in urban centers and towns around the country. Mobility and inexpensive forms of stealth would be incorporated in their design and placement.

Second, many enemies would explore biological advances that have warfare applicability. Chemical and biological weapons are the most obvious threats; but beyond such essentially simple weapons general advances in this field over the mid to long term may dwarf the importance of first revolution systems. Human performance enhancers—particularly those that provide the ability to process enormous levels of data and rapidly make coherent decisions—may be the most significant advances. Stimulants, narcotics, anabolic agents, glycoprotein hormones, and beta blockers have battle potential. Moreover, the medical literature states that "three areas of genetics hold particular promise: gene identification, disease susceptibility, and gene therapy."[8] The fusion of enhanced human abilities with new technologies may be a central element of a second revolution.

Third, a second revolution enemy could skim the cream from the advancements of the first. Then it would have highly precise self-navigation units, reasonable levels of computational power, and somewhat sophisticated capabilities to undertake regional information dominance. This enemy would likely have some ability to deliver precise weapons, although it would probably not have extensive military capital stocks of these assets. It would have developed operational concepts that optimize the use of a few expensive and highly precise systems by mixing them with area strikes by far less expensive weapons. In addition, this enemy might have antisatellite systems, dazzlers to use against our optics, and effective jamming and counterjamming devices.

A fourth category that must not be overlooked is the capability of an enemy to use simple, cheap intelligence systems—and lots of them—to counter first revolution systems. For example, hundreds of fishing boats with only a few carrying intelligence and navigation suites could operate in the littorals acting as markers. Civilian

The Second Revolution

COUNTERS

First Revolution	Second Revolution
precision strike	hardening
	burying
	dispersing
	multiplying
information warfare	primitizing
	isolating
	counterattacking
dominant maneuver	responsive maneuver
advanced sensors	blinding
	dispersing
	multiplying
quality	quantity
	mass
centralized display	diffused display

NEW ELEMENTS OF THE SECOND REVOLUTION

biologics, advanced materials, and nonlinear scientific advances

Predator UAV over *USS Carl Vinson.*

U.S. Navy (Jeffrey S. Viano)

M–2 Bradley digital equipment.

13th Public Affairs Detachment (Richard Puckett)

aircraft, both rotary and fixed wing, could operate in and among high-tech aircraft. In certain situations such primitive systems can be extremely effective, particularly in conflicts fought at a threshold below full regional war.

A fifth concern is the massive use of cheap, crude, but potentially effective cruise missiles and mines (at sea and on land). Even an Aegis system or Patriot battery can be quickly depleted of anti-cruise missiles. Mines are a challenge. Flooding landing zones or littoral seas with them can be an effective denial strategy. Bases for forward forces can be closed by placing large numbers of crude but relatively inexpensive explosives at key points. Destroying or denying something goes a long way toward controlling it.

Weapons of mass destruction, from low-yield tactical nuclear devices to the next generation of chemical and biological weapons, are a possible sixth area of concern. We must not assume that an enemy will be constrained from using such weapons because of our superior nuclear arsenal. It may think we would not respond with nuclear strategic strikes against limited first use of chemical, biological, or tactical nuclear warheads—and it would probably be right. For example, an enemy could indicate that it would employ tactical nuclear, biological, or chemical weapons only at sea, perhaps constraining our ability to respond with strikes on their population centers and effectively limiting our use of similar weapons to the same area.

Seventh, second RMA advancements in armor and materials may eventually counter first revolution systems and pose a significant challenge. Advances in ceramics, steel alloys, polymer composites, and thermoplastic resins hold extraordinary promise. Such scientific innovations will be shared over the Internet and openly taught at American universities. Pre-lubricated surfaces, nylon composites superimposed on steel, diamond coated bearings, and other materials may play in the second wave of RMA technology. All the precision and display capability in the world will not be of use if targets are hardened beyond the ability of such systems to destroy them.

There will also be new operational concepts associated with the second RMA, constituting an eighth area of interest. Clearly, if the central organizing tenet of the first revolution is maneuver warfare, tactics will be developed to counter that approach. What could be called "responsive maneuver" may evolve, which could combine static defenses and rapid counterattacks that seek to

flank, isolate, encircle, and kill maneuvering units. Entrapment and wide-area ambush tactics may develop beyond current levels of expectation. Although today we are enamored with precision and maneuver, the endless competition in warfare of precision versus mass—often manifested in new tactics—tells us that more change lies ahead. The second revolution like the first will generate new doctrine and new tactics, techniques, and procedures.

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Finally, we must not overlook longer term research that goes beyond a second revolution for a truly nonlinear discovery that utterly and instantly changes the calculus of warfare. Given the acceleration of technological advance, it may be possible to leap ahead to ideas that are only dimly glimpsed today—concepts that bend the laws of physics beyond the horizon of common thought. Hyperpropulsion, optics, biologics, control of the electromagnetic spectrum—the possibilities are endless. This may be an area for hedging through research and highly limited prototyping.

In a general sense, the essence of a second RMA is the application of asymmetrical warfare against the United States, which is the leader in first revolution technologies and systems. This is a reverse of the competitive strategic approach that was pursued in the mid-1980s during the climax of the Cold War. While such actions are unlikely to endanger our existence, they can threaten our critical national interests in an increasingly interdependent world. The second revolution may thus provide an enemy with a great deal of asymmetric leverage—that is, influence out of proportion to political, economic, and military strength.

In sum, we must continue our progress through the first revolution. This course of action provides the best hedge against a range of challenges that may confront us in the next century. At the same time we must consider the courses enemies may pursue to achieve a second revolution as they search for asymmetric leverage. Accordingly, we should:

- Set up analysis cells to explore possible decisions by enemies with regard to first and second RMA systems. This should be done independently by the services, Joint Staff, Defense Intelligence Agency, Central Intelligence Agency, etc. The results then need to be compared, fused, and incorporated in upcoming strategic and procurement activities, including those stemming from the quadrennial defense review.
- Evaluate potential second revolution systems for research, development, and fielding. These technologies might include biologics and advanced materials. Nonlinear accelerations in technology and science should be considered.
- Develop operational concepts to overcome potential enemy responses, such as the cycle of maneuver countered by responsive maneuver, responding to primitive systems and tactics, and exploring anti-mass/quantity strikes against fewer though more precise and omniscient systems.
- Recognize that the first revolution will include some costly mistakes, miscues, and maldeployments. Patience will be required in fielding first wave systems, then adapting them to the second revolution.
- Develop a hedging strategy to react as the second revolution accelerates.

During the early debate over the revolution in military affairs, Admiral William A. Owens, the former Vice Chairman, indicated that "the problem with deep, fast, and rampant innovation is not getting people to accept the new but to surrender the old."[9] Ironically, that same sentiment can be applied to our preoccupation with the first revolution as a second looms on the horizon. JFQ

NOTES

[1] William A. Owens, "The Emerging System of Systems," *Military Review,* vol. 75, no. 3 (May–June 1995), pp. 15–19.

[2] Institute for National Strategic Studies, *Strategic Assessment 1996* (Washington: National Defense University, 1996), pp. 185–90.

[3] William A. Owens, "The American Revolution in Military Affairs," *Joint Force Quarterly*, no. 10 (Winter 1995–96), p. 37.

[4] Arjen Lenstra, "Communication," *Spectrum* (January 1996), p. 32.

[5] Thomas G. Mahnken, "War in the Information Age," *Joint Force Quarterly*, no. 10 (Winter 1995–96), p. 40.

[6] David S. Alberts, *The Unintended Consequences of Information Age Technologies* (Washington: National Defense University, 1996), p. 10.

[7] John Naisbitt, *Global Paradox* (New York: Morrow and Company, 1994), p. 12.

[8] Ed McCabe, "Medical Genetics," *Journal of the American Medical Association*, vol. 274, no. 23 (June 19, 1996), p. 1819.

[9] Owens, "Revolution in Military Affairs," p. 37.

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