



MQ-1C Sky Warrior unmanned aircraft system can remain airborne for 24 hours at a time to conduct continuous missions

War in Complex Environments

The Technological Dimension

BY MARTIN VAN CREVELD

Unlike Caesar's Gaul, this article consists not of three parts but of five. The first explains how advancing military technology has contributed to military stalemate among the world's most important states. The second deals with the progress of military technology from 1945 on. The third argues that, in the kind of "complex" wars that have been most common since that date, the technology in question has been largely useless. The fourth focuses on the type of technology that can be used and has proved useful in that kind of war, as well as some of the ways in which it should be used. Finally, the fifth part summarizes conclusions.

Martin van Creveld, formerly of the Hebrew University, Jerusalem, is one of the world's leading writers on military history and strategy, with a special interest in the future of war.

Under the Shadow of the Mushroom Cloud

The first atomic bomb exploded over Hiroshima on August 6, 1945. With a yield of 14,000 tons of TNT, it was 1,000 times as powerful as any previous weapon, yet in less than 10 years, advancing technology made it possible to build weapons more powerful than all the arms ever used in all wars since the beginning

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of history. The race toward greater destructive power peaked in 1961, when the Soviet Union exploded a device with an estimated yield of 58 *million* tons of TNT—the equivalent of over 4,000 Hiroshima-type bombs. By that time, research into the development of even larger weapons had practically come to a halt—not because it could not be done, but because, in Winston Churchill’s words, all they would do was make the rubble bounce.

During the years immediately after 1945, statesmen, soldiers, and the scientists who worked for them and provided them with ideas could still delude themselves that the next war would be like the previous one—give or take a few cities turned into smoking, radiating ruins. However, after 1955 or so, the arrival of so-called nuclear plenty caused that belief to fade. Most people now understood the fact that, should all-out nuclear war break out, there would be neither victory nor economic and demographic recovery in the previously accepted sense of those terms. Possibly there would not even remain a livable

world for humanity—including future generations—to enjoy.

The decades since Hiroshima have not witnessed the most powerful weapons ever devised being used in war. On the contrary, as far as the superpowers were concerned, those weapons helped create a balance of terror that proved remarkably stable and enduring. By the mid-1950s at the latest, both superpowers were fully aware that they had nothing to gain, and everything to lose, from any attempt at annihilating each other. From that point on, whatever confrontations that still took place between them were increasingly limited to relatively unimportant issues in places far away from Washington, DC, and Moscow. From this point on, the effect spread like ink stains.

The first to feel the impact were the superpowers’ close allies in the North Atlantic Treaty Organization (NATO) and the Warsaw Pact. These countries received nuclear guarantees, often bolstered by a physical presence of troops on the ground. It is true that those guarantees could never be made entirely credible; when it came to the clinch, would the United States *really* sacrifice Washington and New York in order to save Munich and Hamburg? Still, in practice nobody ever dared put them to the test, leaving the allies almost as safe against all-out attack as the superpowers themselves. In the end, the demise of the Cold War made the issue more or less irrelevant. It created a situation where the President of France, for example, could declare that his country no longer had an enemy within a thousand miles—and where several other NATO members wondered why they still needed armed forces at all.

To the east of the Iron Curtain, countries such as Czechoslovakia, East Germany, Hungary, and Poland could have built nuclear weapons from the mid-1960s on. However,

any thoughts that they may have had in that direction were smothered by the Soviet Union, which did not favor such shows of independence on the part of its satellites. Now that the Soviet Union is gone and buried, they apparently still do not feel sufficiently threatened to make the effort. Instead, they have contented themselves by joining NATO. Similarly in the West, virtually all “old” NATO members (and, on the other side of the world, Australia, Japan, and New Zealand) could have built nuclear weapons from about 1960 on, yet again, the majority have refrained. Whatever the precise reasons behind their decisions, the fact that most of these countries have everything needed to build nuclear weapons within a matter of months if not weeks is important in itself. It reflects the reality that, whatever may happen in the future, almost certainly they, too, will continue to be safe from all-out external attack even if, and when, the alliances which used to give them protection are dissolved.

Finally, two important NATO members did go ahead and build their own nuclear weapons, Great Britain in 1953 and France in 1960. Both have since constructed technically advanced arsenals. Yet both found that those arsenals were completely overshadowed—by those of, first, the United States and then the Soviet Union/Russia. Except insofar as they afforded some doubtful protection in case the United States failed to live up to its obligations, as long as NATO confronted the Warsaw Pact, the existence of the British and French nuclear arsenals made only little difference to the overall balance between West and East. Now that the Cold War is over, those arsenals, while costing billions to maintain, probably signify even less. Whether their existence means that Britain and France are more “secure” or more “influential” than, say, nonnuclear states such as Germany or

Japan is moot. Be that as it may, the fact is that, in all the decades since 1945, not one of these potentially powerful nations has fought a single large-scale war against any other even remotely as strong. Nor does it look as if this situation is going to change.

Though nuclear developments outside the areas covered by NATO and the Warsaw Pact were much more interesting, broadly speaking, they too moved in the same direction. The first developing country that, amid much fear of impending doom, acquired nuclear weapons was China. At the time, its leader was Mao Tse-tung, a man committed to world revolution whose declarations concerning the need to destroy imperialism even at the cost of nuclear war and the death of hundreds of millions were perhaps the most hair-raising ever made. And yet in practice, the possession of the bomb seems to have caused Mao, let alone his more pragmatic successors, to bare his teeth less often, rather than more. During the 15 years from the revolution of 1949 to the acquisition of the bomb, China was involved in no fewer than four armed conflicts, two of them large: Korea, 1950–1953; Taiwan, 1954; Quemoy, 1958; and India, 1962. Since then, there has only been one: Vietnam, 1979. Even that campaign lasted only a week or so. Picking on a small, weak country, Chinese forces penetrated to a depth of about 15 miles before they withdrew.

India has probably been capable of building nuclear weapons from the late 1960s on. In 1974, the country launched a so-called peaceful nuclear explosion. In 1998, it conducted three nuclear tests. As in the case of China, the overall effect has been to make India less trigger-happy. Between 1947 and 1971, India fought three major wars. Since then, its largest military effort was the so-called Cargill War of 1999, when a semiregular, battalion-sized infantry

force coming from Pakistan advanced a few hundred meters into Indian territory and had to be expelled. Like the Chinese, the Indians now probably possess every type of nuclear weapon from the strategic to the tactical. As in every other case so far, the outcome of nuclear proliferation in South Asia has been peace—or, at the very least, the disappearance of the kind of large-scale military operations that used to take place on the subcontinent until 1971.

Following the Indian tests, Pakistan too exploded three nuclear devices. Torn out of India's rib, Pakistan's very *raison d'être* is to present a counterweight to that country. As one of its prime ministers, Zulfikar Ali Bhutto, once put it, no dispute in the world is as bitter as the one between Muslims and Hindus.

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And yet, as has just been said, in this case too the introduction of nuclear weapons has made a difference. Not only have hostilities been much reduced in size since the last full-scale war took place in 1971, but also both sides have made steps, however hesitant, toward installing some kind of mutually acceptable nuclear regime. First, in 1990, they signed an agreement to refrain from attacking each other's nuclear installations. Later, following a model originally provided by NATO and the Warsaw Pact, they undertook to give advance notice of large-scale military maneuvers they might hold near the common frontier.

Another country widely believed to own nuclear weapons, as well as highly sophisticated delivery vehicles for putting them on target, is Israel. Unlike the rest, Israel, perhaps in fear of triggering an arms race and/or angering the United States, has neither admitted the existence of the bomb nor conducted a test when it was first assembled (probably in 1967). One could argue that, by permitting Egypt and Syria to behave *as if* their adversary did not have nuclear weapons and launch the October 1973 war, this policy of “ambiguity” has been enormously damaging to Israel. Be this as it may, the fact remains that, since then, there have been no more wars of the same kind; even the 1982 invasion of Lebanon fell far short of its predecessors. Two of Israel's neighbors, Egypt and Jordan, are now formally at peace with it. A third, Syria, has lost so much of its military clout that another war between it and Israel seems extremely unlikely. In view of what has been taking place in Lebanon and the Occupied Territories, nobody would call the Middle East peaceful. Still, things are much better than they were before 1973, when major hostilities broke out every few years, leading to thousands of dead and, at one point, raising the specter of a world war.

North Korea already has nuclear weapons whereas Iran is almost certainly doing what it can to acquire them as soon as possible. Neither of these countries is nice and democratic and neither is exactly open about the reasons behind its nuclear program. Yet in the case of North Korea, a few nuclear bombs have done nothing to disturb the peace of the peninsula and may have strengthened it. A very good argument could also be made that a nuclear Iran, provided it is wisely deterred, will result in fewer wars, not more. This, of course, is guesswork. Yet the fact that we do not yet know the consequences

that ownership of nuclear weapons by these two countries may bring is no reason for ignoring the global experience of 60 years. This experience indicates that, wherever the weapons in question appeared—even in small numbers, even when their delivery vehicles were primitive, and even when their owners were as mad as Joseph Stalin is said to have been in his latter days—the outcome was peace. Or, if not peace, then stalemate.

The Decline of Conventional Warfare

When the first nuclear weapons were introduced, it looked as if they would make the military of the countries that possessed them more powerful than ever. In fact, the opposite has happened; faced with devices that could literally blow the world apart, politicians everywhere looked at Georges Clemenceau's dictum—that war was too serious a business to be left to generals—with new eyes. As far as we know, in every country that built the bomb, the existing military chain of command was bypassed or modified in favor of direct control by heads of state. The nuclear arsenal might be entrusted to a separate organization considered politically reliable, as was done in the Soviet Union. Alternatively, technical arrangements were made to ensure that the military could not fire them on their own initiative even if they wanted to. Either way, to the soldiers was left the less responsible task of playing with conventional (read *second-class*) weapons.

Spurred by an unlimited confidence in its power that was the product of World War II, as well as by competition between the superpowers, military technology grew and blossomed. The most important countries competed among themselves by building successive generations of ships, aircraft, missiles, and land-fighting machines—each one larger, more powerful,

and, of course, much more expensive than all its predecessors. Even as existing weapons grew larger, they were joined by some that were entirely new. Among the earliest were helicopters, some of which had been tested even before World War II and which started entering the inventories around the time of the Korean War. Small and light, the first helicopters were used mainly for observation, liaison, and casualty evacuation. As larger and better ones entered service, they were used as flying command posts and for the transportation of troops and of logistic loads. By the early 1970s, helicopters began to be armed with missiles, which gave them a formidable air-to-ground capability. As a result, the balance between land forces—armored ones above all—and flying ones began to shift.

The second important technical advance that changed the face of conventional warfare consisted of guided missiles. The very first guided missiles, intended for antiaircraft and antitank use, were on the drawing boards when World War II ended. By the mid-1950s, some of them had entered service, but their operational impact remained limited. This, however, changed from about 1967 on. Entire

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families of ground-to-ground, air-to-ground, ground-to-air, sea-to-air, sea-to-sea, and air-to-sea missiles made their appearance, improving accuracy a hundred-fold, often generating a one-shot/one-kill capability, and rendering

warfare much more lethal than ever. Whereas originally radar- and laser-guided missiles were very expensive, the introduction of the Global Positioning System made them much cheaper. Particularly in the air and at sea, and to a lesser extent on land, they are now well on the way to replacing all but the smallest unguided (that is, ballistic) projectiles.

Probably the third most important post-1945 development in military technology has been unmanned aircraft systems (UASs). First introduced during Vietnam, and assisted by the advent of microelectronics that permitted improved capabilities without a corresponding growth in size and weight, they have undergone tremendous development. Both on land and at sea, UASs are now used for communication, electronic warfare, surveillance, reconnaissance, target acquisition, damage assessment, air defense suppression, and many similar functions. At the time of writing, the first experiments are under way in equipping UASs with air-to-ground and air-to-air missiles. Should these experiments be crowned with success, as is likely sooner or later, the days of manned aircraft clearly will be numbered.

Coming on top of all these developments, the 1990s witnessed what many commentators called the Revolution in Military Affairs (RMA). The proliferation of precision-guided weapons apart, at the heart of the RMA were vastly improved systems of command, control, communications, computers (that serve to store, process, and display the vast amounts of data generated), and intelligence (that is, sensors of every kind, from ground radar to infrared). Some of the systems are based on the ground, at sea, and in the air. Others are carried by satellites. Between them, they promised vastly improved surveillance, reconnaissance, target acquisition, and damage assessment, as well as

much greater speed, flexibility, and lethality in orchestrating the operations of the above mentioned weapons and delivering ordnance to target.

Whereas preparations for conventional war went on much as before, in practice such wars as actually took place were fought exclusively between, or against, smaller and smaller opponents that, for one reason or another, had not yet acquired nuclear weapons. Though everybody talked about RMA, in practice large parts of it were confined to the United States and Israel. The former was spending more on defense than the next 14 countries combined; the latter was spending proportionally more than twice as much on defense as the United States. In addition, Israel received an annual sum of over \$3 billion in American military aid, which *had* to be spent regardless of whether it made military sense or not. While these two nations raced ahead, most other developed countries kept cutting their armed forces until, by the first decade of the 21st century, they had been reduced to a shadow of their former selves. The situation of many others, particularly in the former Eastern Bloc, was much worse still. Their old, Soviet-era weapons are now only fit for the junkyards. Unable to afford up-to-date weapons, their military capabilities often have been reduced almost to zero.

To sum up, in the developed world since 1945, and in most of the developing nations since 1970 or 1980, the history of conventional war is one of constant, though uneven, shrinkage. True, large-scale instances of conventional war still took place here and there. In some cases, the balance of forces was so skewed that little could be learned from the clashes, as when the United States fought Iraq and, unsurprisingly, crushed it. In others, such as the Iran-Iraq war, so far behind were the belligerents in

respect to modern technology that the conflict in many ways resembled not World War II but World War I (including the use of poison gas, a weapon well suited for stationary positions). While other factors also played a role in the process, the decisive factor was that the more powerful a country, the more likely it was to acquire nuclear weapons and their delivery vehicles. Far from representing progress, as RMA advocates and others claim, much of this was best understood as degeneration. Since the basic security of developed countries is provided by nuclear weapons or the ability to build them quickly, and since cost, even in the United States, only amounted to about 4 percent of gross domestic product, it did not matter. The process might even have gone on indefinitely without disturbing anyone in particular. This, however, did not happen.

From Conventional War to Complex Warfare

While the armed forces of the most important countries—and, increasingly, those of some developing ones as well—talked of an RMA and tried to implement it by buying high-tech weapons, war did not stand still. Instead of fighting each other, more of those forces found themselves trying to oppose others of a completely different kind. A worldwide survey of the 65 years since 1945 confirms that, out of about 120 armed conflicts, some 80 percent were waged by, or against, entities that were not states. Some of those entities at least had a political aim of sorts. A growing number, though, were private—a good example is the Abu Sayyaf organization that has been infesting the southern Philippines—and could barely be distinguished from bands of criminals. Whether or not this was true, few were sufficiently large, sophisticated, or well organized to be called

armies. Even fewer possessed many, if any, of the modern weapons systems just described.

As many episodes remind us—the best known of which are the uprising against Louis XIV in the Palatinate, the Vendée uprising of 1793, and the Spanish guerrilla campaign against Napoleon—even in Europe conventional interstate war was never the only kind. Moreover, between 1700 and 1939, Europeans themselves often fought in America, Asia, and Africa. However, what took place in those

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campaigns could not be compared to European warfare either in terms of size or (unless it was a question of European forces clashing with each other) technological sophistication. Very often, the issues were decided in Madrid, Amsterdam, Paris, or London. By the last years of the 19th century, European (including, *honoris causa*, American and Japanese) military superiority had grown to the point where borders in Africa, for instance, were being drawn by means of a ruler on a blank map without any reference to the local population.

Insofar as the Germans had lost their colonies in 1918, the fact that the Wehrmacht was one of the first 20th-century armies to learn that it did not have the field entirely to itself was paradoxical. As they moved into the countries of southeastern and eastern Europe, the Nazis, on Hitler's explicit orders, deliberately set out to uproot the law of war that for 300

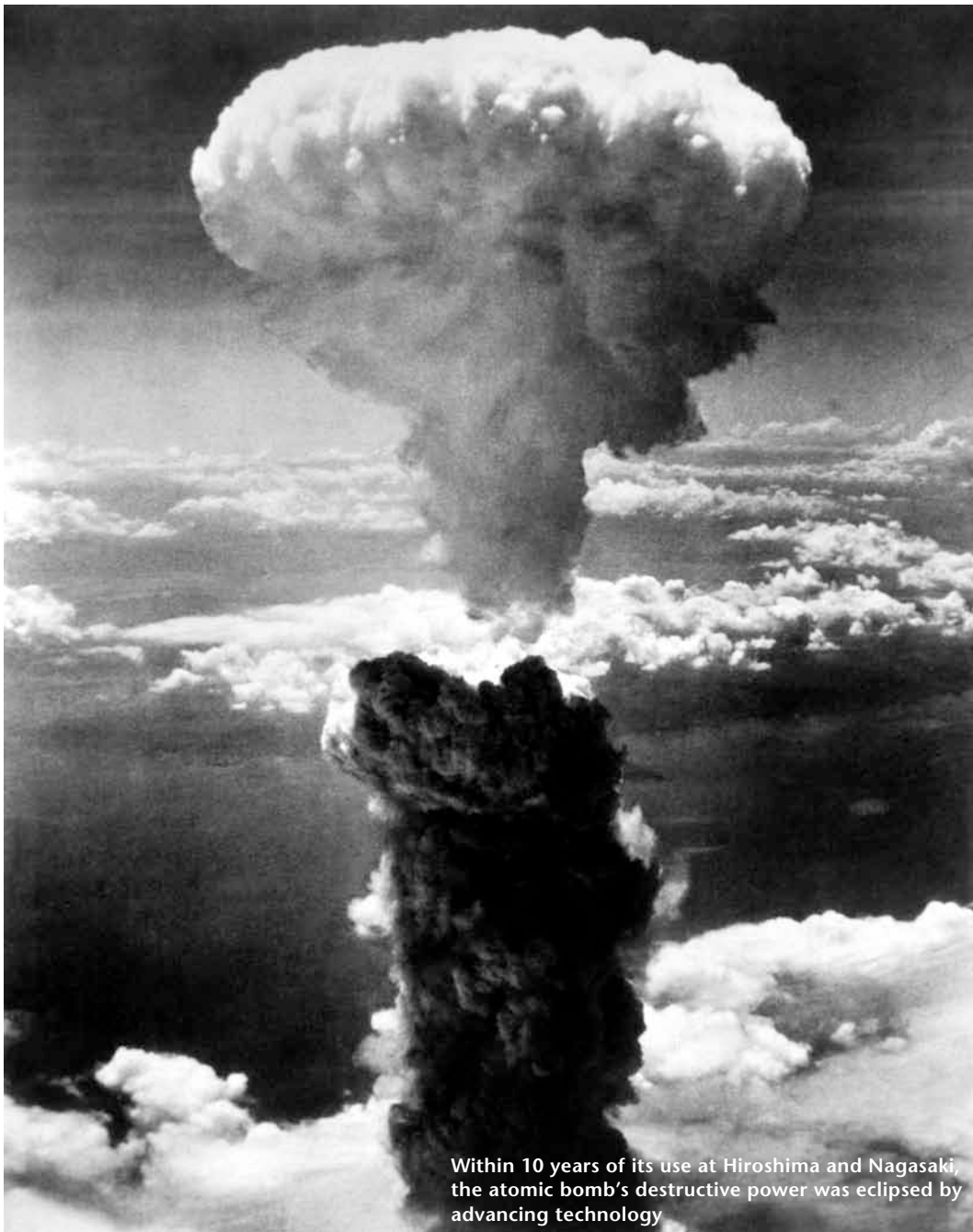
years had sought to offer protection to civilians. As a result, those civilians in turn did not acquiesce in their lot but engaged in guerrilla operations against the invaders. First in Yugoslavia, Russia, Greece, and Poland, then in other countries such as Italy, France, and even peaceful Holland, Belgium, and Scandinavia, the Germans were faced by armed opposition that disrupted their rule, tied down resources, and inflicted casualties. As the number of victims shows, they were perhaps the most ruthless conquerors in history. Yet the more brutal the operations of such organizations as the SS (*Schutzstaffel*), SD (*Sicherheitsdienst*), Gestapo, and *Einsatzgruppen*, the stronger the resistance and the greater the readiness, even eagerness, of people who initially had been prepared to tolerate occupation or even assist it to now oppose it instead.

Whether, had the war lasted 30 years instead of 6, Churchill's 1940 demand that Europe be "set ablaze" from end to end could have been met and the continent liberated even without large-scale operations can never be known. I think the answer is yes. As it was, the resistance in most German- (and Japanese-) occupied countries was cut short, but not before it had shown other people what could be done. The war was scarcely over when, all over colonized Asia and Africa, leaders started claiming that they, too, were subject to unlawful occupation, and that, unless the occupiers withdrew, they too would resort to armed resistance. This logic quickly led to a whole series of wars of national liberation in places such as Palestine (1946–1948), Indonesia (1947–1949), Indochina (1947–1953, 1964–1975), Malaysia (1948–1960), Kenya (1953–1958), Algeria (1955–1962), Cyprus (1959–1960), and Aden (1967–1969). By 1960, the majority of European colonies either had achieved

their independence or were well on their way. Fifteen years later, when the Portuguese finally gave up Angola and Mozambique, scarcely a colony remained.

The colonial heritage of three centuries dictated that most wars of this kind were initially fought against armed forces fielded by Western European countries. After 1975, though, this changed. The Cubans in Angola, Soviets in Afghanistan, Ethiopians in Eritrea, and Israelis in Lebanon and the Occupied Territories (where 16 years' effort ended in a decision to withdraw from Gaza) all tried their hand at counterinsurgency and failed. The same fate overcame the Vietnamese in Cambodia, South Africans in Namibia, Indians in Sri Lanka, and Indonesians in East Timor. Since many of these wars led to millions of deaths, clearly the failures were not due, as has been claimed, to excessive scruples. To the contrary, the campaign that was arguably the most successful of all—the British effort in Northern Ireland—was also among the most restrained and law-abiding. Some of the things the British did were not pretty. Still, they never brought in heavy weapons, opened fire indiscriminately, took hostages, or imposed collective punishments.

How can one explain the victories of people—call them bandits, terrorists, guerrillas, or freedom fighters—who, often so poor that they did not even have proper shoes, took on some of the mightiest armed forces in history and won? While circumstances differed from one theater of war to another, at bottom the answer was always the same. Almost by definition, the more modern an army is, the more advanced the military technology at its disposal and the more specialized that technology for combating and quickly defeating forces with similar, if less well developed, equipment. That technology, though, was



Within 10 years of its use at Hiroshima and Nagasaki, the atomic bomb's destructive power was eclipsed by advancing technology

much less useful in fighting an enemy who did not represent a territorial state, did not have permanent bases or lines of communications, did not possess heavy weapons whose “signature” sensors could pick up, and, most importantly, could not be distinguished from the surrounding population. As far back

as 1941, this rule applied to the Germans trying to combat Marshal Josip Broz Tito's partisans. As of early 2010, it applied equally well to the

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Americans in Afghanistan and Iraq. The jury on these campaigns is still out. Whatever the outcome, in both countries, coping with postcombat resistance has been considerably more difficult, and has led to considerably more casualties, than occupying them in the first place.

At bottom, there are two reasons why much modern military technology is unsuitable to this kind of warfare. First, from time immemorial, most of the campaigns in question took place in theaters where extensive networks of roads, supply depots, communications, and so forth have been unavailable. Since such facilities are vital to the operations of modern armies, however, they must be built from scratch and, having been built, defended. As the American experience in Vietnam and the Israeli effort in Southern Lebanon showed, the result can be the creation of a financial black hole as well as a situation where a lot of the forces, tied down to defensive missions, lose their morale and will to fight. Indeed, often the majority of them hardly fire a shot. Nevertheless, feeling vulnerable at each step, they tend to collapse under their own weight.

The second reason why so much modern military technology is unsuitable for the purpose at hand is just the opposite from the first.

Practically all subconventional conflicts and terrorism campaigns take place in extremely complicated environments. Either they have been created by nature, such as mountains, forests, and swamps, or they are made up of people, their dwellings, roads, vehicles, communications, and means of production. In such cluttered environments, the sensors on which modern weapons rely tend to work less well than in open spaces. Often the latter's range and power are translated into indiscriminateness, which in turn becomes counterproductive and, instead of dousing the flames, fans them.

During the first 40 years after 1945, practically all nonstate conflicts—ranging from subconventional war to terrorism and from wars of national liberation to ordinary crime—took place in the developing world. Since then, however, they have started spreading to developed countries as well—as the events of 9/11, when about 3,000 people in the most powerful country of all lost their lives, amply showed. The results are there for all to see. Even as the USA PATRIOT Act took away some of the liberties that civilized people have been taking for granted, Washington, DC, is being turned into a fortress; where anti-aircraft missiles used to accompany America's forces in the field, now they provide cover to the White House. From Australia to the United Kingdom, other countries are taking similar measures. For example, to defend the 2004 Olympic Games against possible terrorist acts, the Greek government spent \$1.5 *billion*, equal to about 40 percent of the country's annual defense budget; however much many people may regret the fact, armed conflict has indeed entered a brave new world.

Technology in Complex Warfare

The above should not be understood to mean that, when it comes to fighting war

“among the people” and in extremely complex environments, technology is entirely helpless; what it does mean is that we need the appropriate technology to be used by the appropriate organization in the appropriate way.

To start with the basics, the most important advantage that guerrillas, terrorists, insurgents, and the like enjoy over their opponents is stealth. To resort to Mao’s celebrated if worn dictum, guerrillas operate like fish in the sea. The sea feeds them and provides them with cover. By enabling them to compensate for their weakness in fields such as numbers, organization, and equipment, stealth also acts as a true force multiplier. Yet this equation has an obverse side: To remain hidden, insurgents must disperse—the more of them there are at any one place, the more easily they are found. They must also avoid movement as much as possible.

If insurgents stay in one place, their ability to mobilize and operate will be reduced to a minimum. Even worse for them (but better for their opponents), their location eventually will be betrayed or otherwise discovered, and an immobilized insurgent is a dead insurgent. To survive and operate, they must communicate and move. Yet movements and communications are precisely the points that render them vulnerable.

Since prehistoric times, the most effective means to prevent movement have always been physical obstacles. Among them are walls, fences, ditches, swept areas, and the like. Some obstacles consist of roadblocks and are mobile and temporary; others are stationary and permanent. Nowadays, the latter can also be supplemented by mines. Except for the addition of mines, until recently such obstacles were relatively crude and had remained almost unchanged for millennia. However, over the last few decades, technological advances made it possible to supplement

obstacles with a variety of what are often extremely sophisticated sensors. Among them are entire families of closed-circuit television cameras; infrared devices that greatly improve night vision; various X-ray–based machines that can make it difficult to smuggle weapons, equipment, or explosives through gates of every kind; pressure transducers that translate mechanical force into electricity, thus making it possible to detect attempts to cut through fences or climb over them; and UASs that can stay in the air for hours or even days while constantly surveilling.

The correct use of such devices demands that several principles be followed. First, the country should be carved into relatively small segments. In other words, the technology in use must be relatively dense on the ground or else it will simply be bypassed or ignored. Second, since no sensor can do everything under any set of conditions or is impossible to outwit, it is important to combine as many sensors of as many different kinds as possible. Careful planning and design must be applied to ensure that they complement, not cancel out, one another. Depending on conditions and on what we are trying to achieve, the presence of some sensors may be revealed by way of a deterrent measure. Others, though, will have to remain secret and their exact nature and modus operandi carefully guarded. Third, surveillance must be both continuous and temporary. Continuity is needed to make the insurgents’ life as difficult as possible at all times, putting restrictions on what they can do, whereas temporary surveillance, suddenly applied at selected times and places, is intended to respond to intelligence about them or else take them by surprise and keep them off balance.

Until the first half of the 19th century inclusive, practically all communications were dependent on messengers of various kinds, that

is, on physical movement. To that extent, they could be dealt with by means of the mobility-impeding measures and technologies just described. Nowadays, the need for movement has been much reduced, though not eliminated, by electronic communications. To their users, such communications provide tremendous advantages in terms of cost, speed, range, and, above all, flexibility. Often, they permit instant contact regardless of time of day, weather, position, distance, movement, and obstacles of every kind. Yet electronic communications also have vulnerabilities that can be exploited. All kinds of equipment can be used to determine their place of origin and their destination. They may also be jammed or intercepted. Once intercepted, the messages' contents may be deciphered and then either be spoofed or used against its originators and recipients alike. By no means is any of this simple. It requires technological devices of the most sophisticated kind, including, above all, computers to mine, store, sort, and fuse data.

While sensors can identify insurgents, they cannot counter them or fight them once they have been discovered. Hence, it is essential to have at hand various forms of armed forces that can respond to alerts. Some of the forces will be permanently assigned to patrol walls, man roadblocks, and so forth. Others will be highly mobile, consisting of commandoes with appropriate air or ground transportation; helicopters; small, relatively slow aircraft with the appropriate mix of weapons; and, most recently, weapon-carrying UASs such as the American Predator and others. To cut observation, orientation, decision, and action (OODA) loops, the entire complex must be firmly commanded by a single hand. Yet unity of command also creates problems; overcentralization can be as bad as

overdecentralization. It is indispensable that subordinate elements in the system be granted a degree of independence to ensure quick responses and relieve central headquarters of the need to make many trivial decisions.

Provided all this is done correctly, modern technology can indeed go a long way toward dealing with complex war, or war among the people, or whatever else it may be called. No better proof of this fact can be obtained than the following document, originating with the Hamas leadership in Gaza. It was kindly provided to me by General (Ret.) Professor Yitzhak Ben Israel, former chief of Israel Defense Forces (IDF) for technology and logistics:

- ❖ The Zionist enemy has successfully killed many of our fighting brethren, and this at a time when we dearly need every pure fighter.
- ❖ Without a doubt, negligence is one of the main reason[s] why the enemy has succeeded, for his electronic espionage aircraft never leave the skies of Gaza. The multiple eyes involved in the mission never sleep, and standing in readiness behind them, waiting for an opportunity, are the Apache helicopters with their missiles.
- ❖ You are being closely observed 24 hours per day. Each and every day and hour, you are a candidate for targeted killing.
- ❖ All fighters must consider themselves potential targets, and nobody should delude himself by thinking he is not.
- ❖ All brothers must avoid using telephones to determine the timing of their trips and the routes to be used, for all the frequencies on which the

telephones work are being intercepted. You are being followed and pursued.

- ❖ No brother should use a car to move from one place to another, since you do not know who is following you. It may be the owner of the local grocery store, or a friend whose house overlooks yours, or a peddler, or somebody in a vehicle who is observing your house 24 hours a day.
- ❖ In case the brethren have no alternative but using a car, they should drive alone, so as to make sure there are no other activists in it.
- ❖ All the brethren must move only if doing so is really necessary, and if possible do so only in alleyways. Driving along, they must mislead the enemy by wearing certain clothes, changing direction, and so on.

According to Professor Ben Israel, perhaps 90 percent of the successes the IDF obtained in combating the Second *Intifada* between 2000 and 2003 were due to technology.

Four caveats are needed here. First, as the document itself makes clear, technology, however sophisticated and however well adapted to the purpose at hand, is not enough. Equally important is human intelligence, which in turn can only be based on an excellent understanding of the society in which the insurgents operate and its history, traditions, culture, and, above all, language. All these are fields in which technology can only be of limited assistance.

Second, the technology used for waging war in complex environments, while hardly cheap, is not nearly as expensive as that used in regular interstate warfare. We are not talking of hundreds or even of tens of millions of dollars.

Furthermore, many of the skills it demands are not unique to the military but are widely available in the civilian world. This means that given time, the technology will almost certainly be available to the insurgents, too. It is therefore essential for those who wage complex warfare to

every effort must be made to ensure that those members of the population who want nothing more than to continue with their lives as best they can are not hurt either by accident or by design

engage in a continuous process of research and development in order to ensure that the available means not be turned against them and that they retain their technological edge.

Third, it is essential to use the technology, the information it makes available, and the firepower it provides in the most discriminating manner possible. Every effort must be made to ensure that those members of the population who want nothing more than to continue with their lives as best they can, always the great majority, are not hurt either by accident or by design. The worst thing a belligerent engaged in complex warfare against insurgents can do is to hit indiscriminately. Not only will such a policy generate new enemies faster than old enemies can be eliminated, but it will also lead to the progressive demoralization of one's own forces.

Finally, as already said, to be effective the technology needs to be dense on the ground. If the country is too large to allow this—means, after all, are always limited—then choices will have to be made as to where it is best used. In doing so, geographic, ethnic, economic, social, cultural, and military factors will have to be

taken into account. There is no substitute for a thorough understanding of all of those, and the only rule is that there is no rule.

Conclusion

Ever since 1945, technology, meaning *nuclear* technology, has been turning large-scale war between important countries into an extinct species. Not only has nuclear war not broken out but conventional war, for fear of escalation, has been getting swept under the carpet as well. Yet unfortunately the result has not been peace on Earth; instead, conventional war has been increasingly replaced by what, in this journal, is known as complex war. As countless conflicts from the late 1940s to the early 2000s prove, in this kind of war, much conventional military technology is practically useless. To the extent that it is unable to discriminate, it may even be counterproductive.

To fight and win complex wars, entirely different technologies are needed. Broadly speaking, the goal should be to exploit the insurgents' most important vulnerability—namely, their need to move from place to place and communicate with each other. The means employed, as briefly described above, should range from the crudest walls to the most sophisticated sensors and computers. As in all warfare, great care should be taken to shorten the OODA loop (or the “killing chain,” as it is sometimes called) by finding the happy medium between centralization and decentralization. Since the technologies used are often widely available, and since it is only a matter of time before the terrorists will have them as well, continuous research and development are needed. Last but not least, the available technological means will only be of use provided those who use them are intimately familiar with every aspect of the society in the midst of which they operate.

Tall orders, no doubt. But they are also the only way finally to halt the nearly endless series of defeats that the world's most powerful armed forces have suffered in complex wars. **PRISM**