ADVANCEMENT OF TECHNOLOGY AND FUTURE OF WARFARE

Every age has its own kind of war, its own limiting conditions and its own peculiar preconceptions. Each period, therefore, could have held to its own theory of war.

Carl Von Clausewitz

INTRODUCTION

A global technological revolution is leading to social, economic, political and personal change throughout the world like the agricultural and industrial revolutions of the past. The technology revolution with advances in biotechnology, nanotechnology, materials technology and information technology at the vanguard has the potential to transform human quality of life and lifespan, transform work and industry, reshuffle wealth, shift power among nations and within nations and increase tension and conflict.

The technology revolution will not be uniform in its effect across the globe but will play out differently depending on its acceptance, investment and a variety of issues such as bioethics, privacy, economic disparity, cultural invasion and social reactions.

Armed forces in 2025 will achieve unprecedented strategic and operational speed by exploiting information technologies to create a knowledge based organization. It will exhibit tremendous flexibility and physical agility through streamlined, seamlessly integrated organizations that use near fantaices and procedures . The collective result will be a versatile, full spectrum, capabilities based force that can decisively respond to any future global contingency.

Technological Ages of Humankind

Human Society	Duration	Characteristics	Reasons	Warriors	Equipment
Hunter/ Killer Groups	Million BC ~ 10 KBC	"Nature Provided"	Hunting Grounds	Tribal bands	Hand Held/Thrown
Agriculture	10 KBC ~ 1800 AD	Controlled Nature (Plants/Animals)	Farm Lands	Professional Armies	Do
Industrial	1800 – 1950	Mechanized Agriculture	Natural Resources	Mass Level	Mechanical/ Chemical
IT	1950 - 2020	Automating Industry/Agricultures	Societal Disruption	Everyone	IT/Bio/Bots
Bio/NANO Virtual	2020 - ?	Robotization of IT/Bio/Nano/Industry/Agriculture			

Characteristics of Modern Warfare Technology . Some of the characteristics of modern warfare technology are given in succeeding paragraphs :-

Military organizations that can adopt and promote new technologies clearly have a critical edge in "modern" warfare. Adapting the technology developed in the civilian world, such as radios, to military uses was not enough. They had to take the next step and actually foster the development of technology, knowing from experience gained in wartime that this development would be essential Technology is something that can be deliberately and consciously developed by human beings working within complex organizations New technology is useless to military organizations unless their members "formulate a doctrine to exploit each innovation in weapons to the utmost."

Militarily significant technologies are often developed almost simultaneously in different nations. A classic example of this phenomenon is radar, which was under development as a military technology in eight countries (France, the Netherlands, Italy, the United Kingdom, Germany, the United States, the Soviet Union, and Japan) before World War II. Current versions of this same phenomenon are the ubiquitous personal computer and wireless phone. Given the often rapid spread of new technology, the question then becomes, “Who can best use it as an instrument of war?”

There is no guarantee that a new technology, once developed in the laboratory or even in prototype form, will receive adequate funding to become an operational capability. Radar’s historical development also illustrates this point

The development or refinement of one technology may complement the development of another and lead to results that no one had anticipated. An example is the development of the small, reliable cruise missile in the early 1970s. Adding digital processors to radar seekers and radar altimeters gave improved accuracy, stealthiness, and reliability to this new generation of cruise missiles powered by the smaller, more efficient engine. There are many other cases of such synergy in the historical relationship between technology and warfare. Just having a technology, however, is not enough. Military service also needs access to an industry that can produce the equipment embodying that technology in sufficient numbers ossessing a technology, even in quantity, is no guarantee that it will be decisive in war. With night-vision devices—infrared detectors or visual light magnifiers—modern ground forces can fight around the clock. The availability of these devices, however, does not guarantee that they will be used effectively.

The relationship of modern technology and warfare is that the military’s initial experience with a new technology can reveal problems with making the new capability operational. Over time, as the technology is better understood, the number of systems needed (both experimental and operational) to work out the bugs will decline. This means that a military service may have to invest in a number of

prototypes, or even in numbers of different types of operational models, before the technology is proven in operations.

The result of several decades of experimentation and production can be thought of as a funnel, with many options in the beginning (the mouth of the funnel). Gradually, through tests and the evaluation of actual operations, some technological possibilities are abandoned and others matured. The result is a narrowing of options (the throat of the funnel) and the eventual production of large numbers of standard but sophisticated designs.

Relevance of Technology in Future Wars

Armed Forces the world over are being profoundly influenced by emerging technologies specially in the area of High Energy Physics, Material Science, Bio Technology, Sensor Technology and of course in Computing and Communication Electronics. These technologies, either separately or in combination with one another are acting as engines for development of new weapons systems that promise to change in fundamental ways future wars would be fought. A few specific contributions of these Emerging Technologies in development of weapons systems are enumerated below: -

High Energy Physics. The specific area of high energy physics that promise the maximum pay off is Laser Technology. Laser travels at the speed of light, has a range, which is theoretically infinite in vacuum, and it being mass-less photons of light, has the possibility of solving the complex logistics problems of modern warfare at a stroke. These three factors are sufficiently important for serious considerations to be given by defence technologists to the role of Directed Energy Weapons in the future, especially for the destruction of satellites, missiles and aircrafts.

Material Sciences. The contribution this branch of science has made in the sphere of fighter aircrafts and helicopters manufacture is immense, specifically through discoveries of high strength, low alloy steels and polymers that have allowed for significant reduction in their weights. Its application in Armoured Fighting Vehicles has resulted in real tanks having something in common with today's toy tanks, in that they are both being made of plastic. The areas that hold the maximum potential in defence

in the years to come is in the realm of nano-technologies, i.e. technologies associated with manufacturing processes at the molecular level. One of the areas where nano-technology is used is in Micro Electronics Mechanical Systems (MEMS), where small groups of atoms are manipulated by microscopic machines to produce, say, a data storage facility wherein 500 Encyclopaedia Brittannicas would fit on a one sq cm chip. This technology has also resulted in the advent of "army ants" – a class of micro-size mobile robot that perform physical tasks and takes co-operative decisions as a coordinated, homogenous team. They derive their usefulness from their group action. Their use in the Armed Forces are manifold – from clearance of mine-fields to carrying out damage control action in a hazardous environment to identification and transportation of inventories in large ammunition or ordnance depot.

Bio Technology. Besides its obvious use in Bio warfare – it takes only Rs 2000 to produce enough anthrax spores to de-populate an area of one square kilometres (for the same damage, a chemical weapon cost would be Rs 5 lakhs), it has a wide range of application. Another exciting area in biotechnology is Bio-molecular Electronics. The ability to design protein molecules that are organised in pre-determined three-dimensional structures gives the prospect of growing circuits. With semi-conductor molecules included in the protein framework, the bio-chip could be self reproducing, regenerative and of high capacity. Militarily, the added advantage could be resistance to EMP effects, as well as a very compact size for a given capacity. In addition, Bio-Technology would be harnessed to manufacture very sensitive and selective bio-sensors, which would be engineered to act as rapid and cheap bio-chemical agent detectors. Bio-Technology also promises break-through in the exotic area of non-lethal technologies.

Biotechnology will begin to revolutionize life itself. Disease, malnutrition, food production, pollution, life expectancy, quality of life, crime and security, will be significantly addressed, improved or augmented . The following appear to be the most significant effects and issues :-

- Increased quantity and quality of human life. Better disease control, custom drugs, gene therapy, age mitigation and reversed memory drugs, prosthetics,

bionic implants, animal transplants and many other advances may continue to increase human life span and improve the quality of life.

- **Eugenics and Cloning**. These will be very controversial developments -- among the most controversial in the entire history of mankind. Despite these potentials controversy will continue over the following issues :-

    - Eugenics.
    - Cloning of humans including concerns over morality, errors, induced medical problems, gene ownership and human breeding.
    - Gene patents and the potential for either excessive ownership rights of sequences or insufficient intellectual property protection to encourage investments.
    - The safety and ethics of genetically modified organisms
    - The use of stem cells (whose source is human embryo for tissue engineering).
    - Concern over animal rights brought about by transplantation from animals as well as the risk of trans-species disease.
    - Privacy of genetic profiles.
    - Danger of environmental havoc from genetically modified organisms.
    - An increased risk of engineered biological weapons.

Sensor Technology. If miniature devices can detect, process information, move and communicate, they can provide a very fine battlefield sensor network. Some predict the development of small robots, a few inches in size, scattered across the battle space to provide continuous, real time surveillance. Others foresee the development of 'surveillance dust', a cloud of microscopic airborne sensors that could gather and report data for extended periods over large areas. At the extreme, some writers envision 'fire ant warfare', with the battlefield dominated by millions of small machines networked together, recognizing friend from foe, and able to make large areas impassable to enemy troops.

Synergy of Technologies. An exciting system in the realm of converging technologies, currently under development by the United States is the Objective

Force Barrier System, an individual soldier's integrated clothing. Research is being done on this subject by the US Institute for Soldier Nano-technologies, which will emphasise revolutionary materials research toward development of advanced soldier protection concepts. This approach will integrate a wide range of functionalities, including multi-threat protection against ballistics, sensory attack, chemical and biological agents; climate control (cooling, heating, and insulating), possible chameleon-like garments; biomedical monitoring; and load management. The objective is to enable a revolutionary advance in soldier survivability through the development of novel materials for integration into the Objective Force Warrior System.

Major Influences of IT, Bio, Nano Technology upon future warfare are :-

- Ubiquitous miniaturized/networked multi physics, hyperspectral sensors.
- Robotics/Automatics “in the large”.
- Long range precision strike/targeting.
- Info/net Warfare.
- Mini/micro/nano Satellites, Cruise Missiles, UAV’s.
- Binary Bio Weaponry.
- Miniature/ubiquitous “smart mines”.

Future War Scenario

The major significance of these emerging technologies is not that they incrementally increase the capabilities of existing forces but, rather, that they radically alter the traditional theories of military effectiveness. Since the Gulf War, we have seen that forces equipped with precision munitions are able to strike anything they can see. Advanced technologies are bringing smaller, more rapidly deployable and flexible ground forces to conflicts. These forces would benefit greatly by improvements in situational awareness. Soldiers could be equipped with GPS, video and real time interactive voice communications linked to unmanned aerial vehicles (UAVs). Images acquired by these sensors could be transmitted in real-time to commanders up the

chain for them to identify accurately the location of friend or foe, see the battle space from numerous vantage points and respond appropriately. Convoys, subject to ambush, could have UAVs flying ahead to alert them to any problems.

Precision munitions linked to better situational awareness would allow for rapid and surgical strikes that could engage targets while eliminating collateral damage. Increased force protection for our personnel will also be enhanced by emerging technologies. Although situational awareness is a major contributor to force protection, these emerging technologies promise much more. Soldiers can be provided with ultra-light body armour and mine resistant vehicles. Lasers and directional electromagnetic pulse weapons can destroy incoming surface-to-surface, surface-to-air, and surface-to-ship missiles. The rapid introduction of new technologies will change the very nature of future conflict, and this change will continue well into this century. A redeeming feature of these technologies is that they would apply equally well across the full spectrum of conflicts relevant today and as envisaged in the future.

Asymmetric Approach . A little bit of technology applied in the right direction - for example , cheap cruise missiles; distributed air defenses that have no nodes; the ability to place both sea and land mines; the use of cellular telephone technology, and so on --will make an enemy very difficult to take down with a single dimensional approach.

Logistics. Americans took 6,40,000 tons of ammunition in Desert Storm. It took 40 tons of fuel to drop a single ton of bomb. 28,000 containers were taken to Saudi Arabia. The build up to campaign took six months. An American Army division weighs 94,000 ton. It takes another 90,000 tons to sustain it for six weeks. On can't inject speed into a military that is heavy and immobile.

Logistic assets are highly vulnerable in or out of theatre. In and near theatre ports/air fields are possibly unusable. Logistic surface ships and air craft could be targeted by

- "Eggs" (subsurface floating encapsulated missiles implanted by

freighters/SS/air)

- SS (torps/missiles/subsam)
- Transoceanic UUV's, UAV's
- Blast Wave Accelerator
- Cruise, TBM's
- Mines.

Given the Superb/Ubiquitous World Wide Sensor Suites and Precision Strike Capabilities the Following will not survive :-

- Runways.
- Surface Ships.
- Manned (logistic/combat) Aircraft.
- Manned (logistic/combat) Ground Vehicles.

How To Apply Technology To War

Defense officials have given a great deal of thought for decades about how to apply technology to modern war. There has also been a great deal of progress in recent years in understanding how technologies develop and how they can be adapted to warfare at an acceptable cost to the Nation. In July 1999, for instance, the General Accounting Office of USA published a report entitled "Better Management of Technology Development Can Improve Weapon System Outcomes." This report, described how certain measures, referred to as technology readiness levels, could be used to gauge a technology's maturity. Put another way, the report argued that there were quantitative means for determining whether a given technology was ready for development in a military acquisition program. Though there is still no consensus within the defense acquisition community that these measures are in fact completely reliable, the work to create and then test them in actual programs is a sign of the

progress that has been made in linking new technology to measures of its production (and hence its military) potential.

There will be a shift from chemical explosives in warheads to directed energy weapons. However, chemical explosives and propellants will still be manufactured and used; unguided, chemically explosive small arms and other weapons will have roles for many years to come. For example, chemical explosives can generate electromagnetic pulses to overload many existing digital circuits, thereby giving chemical explosives a new lease on life even in a network-centric battlefield. Such technological developments are examples of how certain existing technologies will have, at least for a while, important roles to play in warfare.

Future weapons (although not necessarily their platforms) will zero in on targets faster. The potential to acquire and share real-time data will grow, and weapons will be able to act on this data to strike mobile targets. Deployment of hypersonic missiles can be expected by 2020, if not sooner. We should, by then, also see missiles that can loiter above a battlefield at subsonic speeds yet are capable of suddenly attacking at *hyper*sonic speeds.

Admiral William Owens, USN (Retd.), former vice chairman of the US Joint Chiefs of Staff, has been saying for years that the critical “revolution” is informational. In *Lifting the Fog of War*, Owens argues that microprocessors were the key element in unmanned aerial vehicle (UAV) development. He defines the *ongoing revolution in military affairs* as “the ability to achieve *integrated sight*—the stage where the raw data gathered from a network of sensors of different types is successfully melded into information.”

It is not enough to watch a limited number of critical technologies; a great number have to be tracked and assessed. For example, “Avionics Miniaturization.” is possible because computer chips have gotten not only smaller but also more capable and reliable. What technologies have improved so that the chips could get better and smaller and cheaper? Photolithography is one; another is the manufacturing of reliable silicon substrates. Indeed, what we have seen in this particular field is the application of quantum physics to industrial processes, but the details of how this is

done are beyond the understanding of even well educated officials. In other words, understanding technology so as to direct it is harder than it was just a few decades ago, and many of the people who understand new technology are not working for the Ministry of Defence. How can their expertise be used to advantage of armed forces?

How, then, are Defence leaders to know which specific technologies to watch and which to invest heavily in? A very interesting recent paper on the military potential of lasers illustrates this dilemma. The author, Mark Rogers, claims, “Laser technology has matured so substantially in recent decades that the United States now has the capability to use lasers from space-based platforms to change radically the conduct of war.” Yet he also admits that semiconductor lasers, which are most efficient in converting “input energy into laser light,” are not suitable as weapons. Moreover, he acknowledges that “it is difficult to point laser beams with great precision,” and therefore it is not easy to keep the focused beam on the target long enough to destroy it. In consequence, Rogers admits that a space-based laser weapon would be expensive, vulnerable to antisatellite weapons, and face “significant engineering challenges.” So what are Defence leaders to do? Invest heavily? Or wait, while investing in limited advanced research projects?

There is no easy answer to these questions because we cannot see the future clearly. One or more nascent technologies may turn out to be “sleepers,” apparently useless initially, but very important once developed. For example, there are MOD officials who believe that exotic nonlethal weapons might have a bright military future. There are chemicals that cause metal to turn brittle, for example, and other chemicals that put a stop to combustion in vehicle and aircraft engines, and even sticky foams that could immobilize soldiers without otherwise harming them. It is not possible to predict what new and militarily useful technologies will come out of basic scientific research labs. It is not possible to eliminate technological surprises or to prevent key developing technologies from drawing scarce resources away from investigating exotic but promising new technologies. The balance between pursuing exotic, risky technologies and pragmatic, well-understood technological developments is what is required.

The Armed Forces have to prepare the physical condition and training of soldiers. They must prepare the minds of the next generation of military leaders to handle the challenges of the battlefield. Intellectual preparation must be a recognition of what will not change the fundamental nature of war. The fact is that fog, friction, ambiguity and uncertainty will dominate the battlefields of the further just as they have in the past. We should not forget what the North Koreans, the Chinese and the North Vietnamese were able to do against technologically Superior American forces in 1950, and 1960.

Combat in 2025

> *As the weapons of war change so will the nature of war change, and though this is an undoubted fact, tactically it must not be overlooked that weapons change because civilization changes; they do not change on their own account*.
>
> —J.F.C. Fuller

Future Conflicts

The type of threats that established nation states would face are :-

- Asymmetric threats in which state and non state adversaries avoid direct engagements but devise strategies, tactics and weapons to minimize strength of nations and exploit perceived weakness.
- Strategic WMD threats including unclear missile threats. The potential for unconventional delivery of WMD by both state and non state actors will grow.

Regional Military Threats. The risk of war among developed countries will be low. However, relatively frequent small scale internal upheavals to less frequent regional interstate wars would continue. Their potential lethality will grow, driven by the availability of WMD, longer range missile delivery systems and other technologies.

Internal conflicts stemming from religion, ethnic, economic or political disputes will remain at current levels or even increase in number.

Internal Conflicts

- ✓ Many internal conflicts, particularly those arising from communal disputes, will continue to be vicious, long lasting and difficult to terminate -- leaving bitter legacies in their wake. Gujrat is an example.
- ✓ They frequently will spawn internal displacements, refugee flows, humanitarian emergencies, other regionally destabilizing dislocations.
- ✓ If left to fester, internal conflicts will trigger spillover into inter state conflicts as neighboring states move to exploit opportunities for gain or to limit the possibilities of damage to their national interests.
- ✓ Week states will spawn recurrent internal conflicts, threatening the stability of a globalizing international system.
- ✓ States with poor governance, ethnic, cultural or religious tensions, weak economies and porous borders will be prime breeding ground for terrorism.

➢ **Low Intensity Conflict Operations.** This being the most likely form of war in the foreseeable future, we need to respond quickly to the needs of LICO. Our important requirements would be as follows :-

- Weapon locating system.
- Bunker location system.
- Detection of trans border movement.
- Mines and IED detection and neutralisation equipment.
- Hand held direction-finding equipment for mountainous and urban areas with accuracy of one degree.
- Voice, radio and radar finger printing.
- Use of non-lethal ammunition from conventional weapons.
- Personnel protection equipment and clothing.

- Surveillance over unheld areas in mountains and deserts.
- Perimeter surveillance and protection.

Trends in Global Defence Spending.

Defence related technologies will advance rapidly particularly precision weapons, information systems and communications. The development and integrated application of these technologies will occur mostly in advanced countries, particularly the USA. Given the high costs and complexity of technical and operational integration, nations will assign high priority to the indigenous development of such military technology.

Many states would attempt to diversify sources of arms for reasons that vary from fears of arms embargoes to declining defence budgets or to a desire to acquire limited numbers of cutting edge technologies. Their effects would include developing a mix of indigenous production, codeveloping , coproducing or licensing production and purchasing entire weapon systems. The above would suggest the following :-

- Technology diffusion for those few states with a motivation to arm and economic resources to do so will accelerate as weapons and military relevant technologies are moved rapidly and routinely across national borders in response to increasingly commercial rather than security calculations. For such military related technologies as the GPS, satellite imagery and communications, technology superiority will be difficult to maintain for very long . Strategy, doctrine and training will increase in importance in deciding combat outcomes.
- Export regimes and sanctions will be difficult to manage and less effective in controlling arms and weapons technology transfers.
- Advantages will go to the states that have a strong commercial technology sector and develop effective ways to link these capabilities to their national defense industrial base.

It is very difficult to forecast which technologies, in what quantity and form, will be incorporated in the military systems of future adversaries. The question is not which technologies provide the greatest military potential but which will receive the political backing and resources to reach the procurement and fielding stage. Moreover, the civilian technology development already is driving military technology developments in many countries.

The system and technologies which are to be augmented by the Army are :-

- **Technology**
  - Hybrid Power Systems.
  - Logistics efficiencies (fuel efficiency ,ultra-reliability, weight reduction)
  - Human engineering/ cognitive engineering
  - Signature control(including counters).
  - Protection schemes for land systems (including active protection)
  - Advanced materials.
  - Affordable precision and alternate lethality means.
  - Alternative propellants.
  - Non lethal capabilities.
  - Biological and chemical protection, antidotes and vaccine.
- **Systems**
  - Situational Awareness.
  - Global maneuver platforms.
  - Advanced Air frame-Heavy Lift/ Tactical Utility Lift.
  - Future Fighting Ground Craft.
  - Autonomous and Semi Autonomous unmanned systems (air, ground,sensors).
  - Advanced Fire Support System.

- Assured intelligence, surveillance and reconnaissance .
- Soldier as a system.

The following can be safely assumed :-

- Proliferation of IBM, IT, Precision strike/targeting, ubiquitous micro sensors, camo/spoofing, robotics, bio/chemical munitions.
- Logistic assets highly vulnerable in or out of theatre.
- In and near theatre ports/airfields possibly unusable.
- Beam weapon increasingly in use.

Beyond 2010 knowledge dominance will no longer be enough. We must have :-

❖ **Speed to exploit knowledge**. Forces must move to survive and succeed.

They are of two types :-

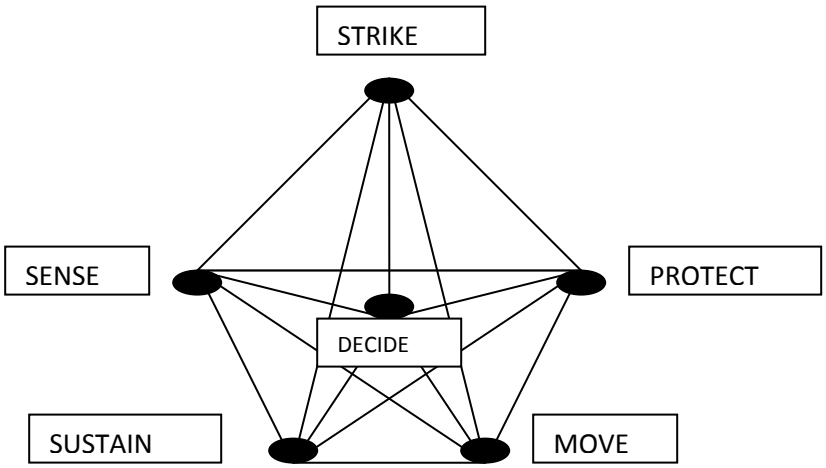
- Linear Speed for Strategic Preemption
- Angular speed to anticipate, out think, gain positional advantage.
- Pulsed continuous operations.
- Agile, high operational transition capability
- Adaptive, full spectrum forces.

(2025) Warfare Issues

In today's major weapon systems, the six key combat functions are built into the same platform. They are :-

- Protect.
- Sense.
- Decide.
- Mov.
- Strike.
- Sustain.

In the tomorrows systems of system in the era of Network Centric Warfare, the six key combat functions will be distributed across the battlefield in multiple platforms.



Trends Summary. The summary of future trends are :-

- Tele-everything.
- U.S. just “one of the crowd” economically.
- “Warfare on the cheap,” many potential “Peers”.
- Warfare Increasingly Robotic.
- Survivable/Affordable power projection via deep water subs and Blast Wave Accelerators.
- Logistics Defense increasingly worrisome.
- Machines as creative/”smart” as humans “Robotics” the “norm”.
- Zeroth order “warstopper” – Binary bio into nation’s agriculture./food distribution system (every home/fox hole).
- Next level of concern : Ubiquitous/Cheap micro-to-nano EVERYTHING (sensors, munitions, weapons swarms/hordes).
- Battlefield attrition/CNN syndrome.

CONCLUSION

We have now entered the 21st century, and several serious questions and challenges face our military that must be addressed. The first has to do with the growing number of these nontraditional threats. Will these continue to increase with new types added to the confusing mix, and will we rely on the military as our principal instrument to deal with them? Second, can we afford the kind of military that can meet all the potential challenges ahead that could span the spectrum from conventional warfare with a global power to confronting strong regional powers with significant capabilities such as weapons of mass destruction to responding to the growing list of asymmetric threats? The third question relates to the much-needed military reform. Can the military change, reform, or transform to meet the challenges of the new century and adapt to the rapid development of new technologies that could radically alter the military as we know it today? The fourth issue deals with interagency reform, which is necessary to move in parallel with military reform. Can we meet the demand for better decision-making and the integration of all instruments of power (political, economic, informational, etc.) to solve the multidimensional challenges ahead?

We must, of course, take advantage of the latest technology and incorporate it into our military forces. In doing so, however, we should constantly ask ourselves: what will a given technology drive our adversaries to do? That will be a key issue of 21st-century land warfare, and those who carefully examine the answers will prevail on tomorrow's battlefields.

What really are the essential military implications of the so-called information revolution, for example? On September 11, 2001, terrorists attacked the United States from within. They financed their preparations with funds that had been transferred electronically from banks in the Middle East to banks in America. With

those funds, they bypassed the forward-deployed, highly trained, technologically sophisticated forces of the United States. In effect, an apparently “ordinary” electronic funds transfer was a key element in a larger strategy of terror.

As we look to the future we must continually remind ourselves--and our decisionmakers--that war, notwithstanding its technology, will remain the savage clash that it always has been. We will face adversaries who will not play by our rules and, indeed, who see our values as vulnerabilities. As James F. Dunnigan noted in his recent book on future war, "If the opponents are bloody-minded enough, they will always exploit the humanitarian attitudes of their adversaries." Make no mistake about it, technology cannot transform war into a genteel electronic exchange as some hope. Video games are not the paradigm for warfare in the next century.

Moreover, we should not expect our enemies--and especially those of other cultures--to necessarily use technology in the same way we do, or to employ high-tech weapons as we would. Perhaps in considering the effect of high technology on warfare, it is worth recalling the words of Vice Admiral Charles Turner Joy from more than 40 years ago: "We cannot expect the enemy to oblige by planning his wars to suit our weapons; we must plan our weapons to fight war where, when, and how the enemy chooses."

The future of science and technology is often thought of and described in fantastic terms, even while revolutionary changes are taking place right before our eyes but are not necessarily recognized as such.

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