STRATEGY RESEARCH PROJECT

THE FUTURE OF INFANTRY: MANEUVER IN THE TWENTY-FIRST CENTURY

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ABSTRACT

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The thesis of this paper is that infantry based forces will become the dominant land combat arm and the force of choice in future operations. This situation is a result of the changing geopolitical environment. Future battlefields will be collocated with traditional ethnic, religious and political "fault lines" which predominantly occur in Asia. Potential regional opponents will possess a significant armor and infantry capability along with some niche technological advantages, which will make them formidable adversaries. At the same time, the American domestic environment will affect national military strategy, forcing the continuation of force reductions and the dismantling of the heavy defense industry. The requirement for cross spectrum versatility and strategic mobility along with rapid lightweight technological developments will place infantry in the lead as the force of choice for operations across the spectrum. Information technology along with lethality improvements for the infantry, artillery and aviation will drive the formation of a new more dynamic combined arms team capable of the full spectrum dominance required in Joint Vision 2010.

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The thesis of this paper is that highly mobile infantry based forces combined with increasingly lethal artillery and aviation will become the dominant land combat force of the future. This change will be brought about as the geopolitical environment evolves into a new set of circumstances requiring capabilities traditionally associated with infantry. At the same time, domestic requirements will continue to shape the direction of national strategy and force structure, focusing on lighter more economical dual use technologies. As technological developments create the requirement and the capability for a dispersed and expanded battlefield, mobility requirements will expand the roles of aviation due to its speed and artillery due to its range. Infantry, with its abilities to merge dismounted mobility with aviation and to provide information to artillery systems even in close terrain, will be the key to full spectrum dominance. In turn, the infantry force will require significant changes in how it is selected, organized, trained, employed and supported in order to meet the challenges of future conflict.

THE FUTURE STRATEGIC ENVIRONMENT

Geopolitical Environment

Current geopolitical trends, if they continue, will serve to spark future instability and, potentially, armed conflict. Globalization of the world economy will likely continue with regional economies extending across international borders. Development of regional economies will reduce the likelihood of general war. However, world economic tri-polorization into advanced, industrial based and developing (or have not) economies is likely to produce popular resentment and conflict in certain regions.[1]

This trend becomes accentuated by population growth, 95% of it in the developing world. The result will most likely be a population bulge of young people

surging into the cities of the developing world in search of economic prosperity. If this prosperity is not forthcoming, the opportunity exists for massive ethnic, cultural and political strife. Regions where economic disparities coincide with competing cultural, political and ethnic systems provide the most potential for conflict. Matching these areas to the vital interests of the United States defines the future battlefield.[2]

Regionally, Asia contains the largest number of "fracture plates" based on ethnic, religious and political orientation. Unfortunately, it also contains most of the seven major choke points to world trade, five of which are controlled, along with the bulk of the world's oil, by states with Islamic governments. This same region represents the epicenter of population growth as well, resulting in the potential hot spots reflected in the United States' two most likely current military contingencies.[3]

Iraq, Iran, North Korea, China and India represent those nations most capable of regional success against the United States with China considered the most likely peer competitor by 2020.[4] The capability of these regional competitors is growing. Most of them possess a potentially lethal armored threat. In fact, over 46 nations in the world today have 300 or more tanks in their inventory of T-55/56 or better quality, increasing the threat to light forces as currently configured. This is more armor than is found in a U.S. armored division (259) and more than is prepositioned regionally or afloat by either the Army or the Marines.[5]

Armored threat aside, a majority of regional armies are infantry heavy as well. Precision firepower against such a large mass is likely to prove ineffective, especially considering the combination of urban and rough mountainous or forested terrain that

characterizes much of the third world. Even with coalition partners, the United States would be hard pressed to bring effective military power to bear in such a scenario. Currently the world's eighth largest army, behind Vietnam, limited ground force strength would prohibit effective U. S. operations in these regions.[6]

Given the foregoing coupled with high technology niche capabilities targeted at U.S. vulnerabilities and low visibility state sponsorship of terrorist organizations combine to make many of these nations potentially formidable opponents. Iran in particular possesses a growing capability to influence the Persian Gulf through the continued acquisition of antishipping missiles, attack submarines, short range ballistic missiles, and weapons of mass destruction. These potential challenges must be placed within the context of the American domestic environment to determine feasible solutions.

Domestic Environment

American society has increasingly given domestic affairs its attention as its most vital interest, and therefore generally supports smaller government, smaller budgets, and domestic economic development. Without a clearly defined threat, the American people have traditionally focused inward, frequently at a tremendous future cost. In the post cold war era this has meant downsizing of military forces and virtual demobilization of the military industrial base including research and development. At the same time, high technology civilian industries have increased dramatically resulting in what some have referred to as the information age.

The security implications of these trends are many. Heavy industry, the backbone of past conflicts, can no longer support rapid mobilization nor could it sustain a lengthy

conflict where there were significant equipment losses. Smaller defense budgets mean less flexibility to purchase high cost single or special use systems which cannot be applied to a wide variety of missions in both peace and war. Smaller budgets also mean fewer forces which must maintain their relevance through validity across the spectrum of conflict. To complicate matters, the accelerating cycle of technological development increasingly threatens to render large new weapons systems obsolete before they can be fielded. No nation can afford such a strategy.[7]

National Strategy

Today's national security strategy of engagement and enlargement is preventive in nature, seeking to reduce the tensions and uncertainties which cause war. If the preventive approach fails, this strategy at present specifies a force capable of fighting two nearly simultaneous major regional conflicts. At the same time, economic pressures to reduce the deficit have created force cuts, seriously reducing the capability to execute the required operations in this worst case scenario.[8]

The corresponding national military strategy employs the concepts of overseas presence and power projection to meet the two conflict requirement with a smaller force. This strategy requires peacetime engagement to enhance regional security, the power to rapidly and forcefully react to crises in order to deter conflict, and the ability to fight and win two major regional contingencies through rapid force generation and projection followed by rapid intertheater transfer to win the second fight.[9]

Joint Vision 2010 and Army Vision 2010 translate these strategies into the future geopolitical and military environments. The requirement for full spectrum dominance

(across the complete range of military operations) with a greatly reduced structure plays a critical role in every facet of force development.[10] Units must not only be flexible across the spectrum, they must also be rapidly adaptable in organization, doctrine and training to meet the accelerated changes in opponent capabilities. At the same time, power projection will remain the principle strategic concept for operations in 2010, regardless of structure.[11]

Deployability and Power Projection

A strategy that employs fewer forces implies greater agility. This has led to a number of service driven strategic concepts such as prepositioning (both ashore and afloat), forward presence, "Forward From The Sea" and "Global Reach." Each of these concepts has its strengths and weaknesses.

The maritime concept of "Forward From The Sea" offers an invaluable capability. However, it is limited by range to littoral areas, and assumes that known maritime choke points will be available for transit. Additionally, given the proliferation of anti-ship missiles, power projection "from the sea" is by no means a forgone conclusion. The Falklands crisis and more recently the damage done to the USS Stark by a single air launched missile clearly demonstrate the potentially drastic effects on shipping by Exocet and Silkworm type systems. This is especially true in restricted waters such as the Persian Gulf. The rapidly increasing standoff of these missiles, now up to 200 kilometers, intensifies the difficulties associated with the projection and support of land forces ashore.[12]

The airpower concept of "Global Reach" also offers great potential with certain limitations. While only a certain percentage of the earth's surface is adjacent to water, 100% is covered by air. When flight hours are compared to steaming days, air power offers a response differential in time over naval power. It is versatile and applicable across a wide range of tasks in both peace and war and can be maintained in the reserve component with virtually the same degree of readiness as an active duty unit.

However, lack of basing and overflight rights and the requirement for suitable landing areas to build up combat power can limit effectiveness. Additionally, airlift has only a limited capability to deploy heavy combat forces in any quantity, and airfields are not immune from interdiction. The proliferation of shoulder fired surface to air missiles which are virtually impossible to locate would be devastating if positioned along known air routes into aerial ports of debarkation.

Landbased concepts of forward deployment and prepositioning attempt to bridge the gap between capabilities and requirements. The inability of airlift to deliver large mechanized forces and the general unwillingness of national authorities to adequately support the heavy forces most in need of sealift have led to the prepositioning of stocks of heavy combat equipment around the world. This concept has its vulnerabilities as well.

Prepositioned equipment is vulnerable to sabotage or denial through weapons of mass destruction. These same stocks may be located where they cannot support a crisis response. Prepositioned stocks add to the cost of modernization as they must be upgraded to keep pace with the force. Deploying a unit trained on one version of equipment to another amounts to deploying an untrained force and invites disaster.

Power projection in the future implies two requirements. First, the force must be strategically mobile. For fast breaking crisis response, this implies a light, infantry based force. Second, the projected force must be equal to the task. It must contain significant combat power to include sustainability and be capable of fighting on arrival. The impact of technology will soon be capable of providing a force with the required strategic, operational and tactical mobility and combat power.

The Future Battlefield

At the tactical and operational levels of war, terrain and mission combine with the enemy situation to create a wide variety of situations which stress or limit combat potential. Ground combat varies across a spectrum from extremely open to very close or covered terrain. Areas with and without cover require organizations with the capability to execute different tactics. Missions themselves may vary from high intensity conflict to disaster relief. Units incapable of adaptation across this spectrum constitute unusable force. In a small military; the most flexible organizations offer the greatest utility.

The open ground fight is characterized by dispersion and great depth creating conditions for a wide open fluid battlefield. Open terrain battle requires air superiority to survive, and units must be highly mobile due to the dispersed nature of operations. Weapons of mass destruction drive the requirement for dispersion to provide less lucrative targets to the enemy. This dispersion for survival requires sharp reductions in administrative and logistical requirements, as the battle becomes nonlinear and fixed ground lines of communication and bases become more and more vulnerable. The line

between offensive and defensive operations becomes increasingly blurred and combined as the enemy becomes the focus of operations.

The widely dispersed nonlinear nature of open terrain battle shifts traditional cavalry roles of reconnaissance and disruption to aviation assets, as ground mobility becomes increasingly unable to cover a geometrically expanding battlefield. The enemy must be found well forward with airborne assets, and engaged with highly mobile ground and air combat systems operating in combination with long range precision fires. Fixing is not required to complete destruction provided there is real time linkage between situation awareness and a precision engagement capability.

Open terrain combat, previously the forte of armored forces, could become the arena of an agile aviation, infantry and artillery team where combat power is generated as a function of mobility, information dominance and precision firepower allowing greater capability to dominate a larger battlespace. The traditional infantry role focused on getting the tank into position and providing it protection is shifting in support of aviation and indirect fire assets, insuring that forward arming and refueling points and forward operating bases are protected. At the same time infantry forces will disrupt the enemy with long range direct fires beyond tank main gun range and position themselves to assist in sensing for the delivery of precision indirect fires.

Open terrain combat has held the attention of the armed forces for years. However, unlike most computer simulations (and a majority of major training centers), the reality of terrain in war is different. The earth is neither pleasant nor flat. Close terrain conditions limit information (especially that gained by sensors), ground mounted

mobility and precision lethality. Forests, jungles, mountains, urban areas and fog or smoke all produce, to one extent or another, the same effect, negating many if not most technological advantages.

The close terrain fight changes the equation of combat power dramatically. Close conditions challenge the capability of combat units to find the enemy for targeting and even when found may prevent effective use of supporting fires. Closeness of terrain implies closeness of contact demanding quick and accurate identification and precision of fires at all echelons, especially the individual rifleman. The utility of heavy massed firepower diminishes in an environment characterized by hugging tactics, which endanger friendly troops or noncombatants.

The close terrain fight represents not only the most difficult, but also the most likely future battlefield condition. Politically unstable developing nations are increasingly characterized by an environment of urban sprawl. Frequently the interior of such countries contains close terrain with low quality road networks, especially bridging, complicating mobility and making the situation generally unsuitable for large scale mechanized operations. Large numbers of noncombatants increase tactical complexity and significantly complicate combat operations. Aerial reconnaissance is limited in effectiveness, and mechanized operations are extremely vulnerable to attack due to their inability to overcome terrain restrictions. While this does not discount the importance of open terrain combat, it does argue strongly for a shift toward forces more capable of urban operations or at least flexible enough for employment in both environments.

THE ROLE OF INFANTRY

Throughout history the infantry has remained the most flexible of arms because it can fight in so many ways and places. No other component of the ground force can perform the wide range of infantry missions. Aviation is fleeting in nature and cannot retain terrain. Armor is partly deaf and blind, increasingly restricted by terrain, difficult to conceal and vulnerable to an expanding variety of weapons while at the same time impossible to deploy rapidly and difficult to sustain in crisis areas. Artillery, although increasing its capabilities, is incapable of engaging small fleeting targets at close range without endangering friendly personnel. Like armor, artillery is of limited use in certain environments and of little value in post conflict operations or in most military operations other than war.

The basic stand alone combat mission of the infantry is unlikely to change in the long term. Infantry will continue to "close with the enemy by means of fire and maneuver to defeat or capture him, or to repel his assault by fire, close combat, and counterattack." In order to accomplish this mission, infantry performs six critical tasks: find, fix, finish, disrupt, protect and control. Although these tasks may be accomplished alone, they are usually done in concert with the other arms and services.

Infantry has always played an important role in gaining contact with the enemy. Traditionally an aspect of battle dominated by cavalry, this critical function is essentially an infantry task in close terrain and at the low end of the spectrum of conflict. Even in open terrain, infantry may be the force of choice due to its low signature, if it can be placed in the proper position with good communications.

Despite the expanded capability of current and projected sensors, close terrain (or visibility conditions) still restrict their use. While there are developmental programs targeted at foliage penetration, it is unlikely that such programs will provide a tactical capability in the near term. Nor are they likely to solve the same visibility problem for urban terrain or be able to distinguish combatants from noncombatants.[13]

Once found, the enemy is usually fixed to facilitate his destruction. The requirement to fix enemy forces is as old as warfare. Fixing allows "time dominance" of the enemy. When an enemy force is fixed, it loses flexibility and initiative and leaves itself open to the massing of effects, which frequently require time to either maneuver into position or to coordinate for maximum impact. Infantry is not the only force capable of fixing, however it is the most capable one, especially when combined with other arms. The requirement to fix diminishes in importance proportionally with real time situational awareness and response capability. Even with perfect situational awareness, however, fixing the enemy facilitates the massing of effects.

As the principal close combat force for all terrain, infantry forces are required to finish the battle, however it may be fought. Other forces are incapable of clearing the terrain required to consolidate victory and have difficulty in capturing enemy personnel. The implication that infantry must always come to grips with the enemy to finish him is misleading. While close combat is the essential infantry task, weapons developments clearly indicate that in certain conditions infantry will fight at extended ranges. The meaning of closing with the enemy must be modified to include long range engagements and "fire fights" along with its traditional implication of bayonet and rifle butt.

Disruption is traditionally a light force function, whether cavalry or infantry, and multiplies the effect of combat power by creating vulnerabilities and destroying enemy synchronization. In essence, disruption magnifies the friction of war for the enemy. Infantry by virtue of its exceptional mobility and low signature acts as an excellent disrupter of enemy offensive or defensive plans. Traditionally a critical disruptive force for armor, allowing it to exploit the disruption of enemy defenses, infantry has the potential to expand this role in support of aviation.

Protection of valuable resources remains a critical infantry task across the spectrum of conflict. Commanders of fire support and air defense assets habitually request infantry security forces to protect their vulnerability to ground attack. This is not a new requirement. From fortress troops to fire bases in Vietnam to aviation forward operating bases in Desert Storm, infantry support has been critical to protecting valuable assets. Even mobile armored forces require infantry for security. Today's crew served systems do not possess the depth to maintain constant twenty four hour security and must have infantry for close in protection and early warning, especially in close terrain or bad weather. This requirement is expanding as the battlefield becomes more non-linear.

Control of populations and critical terrain is an infantry intensive and essential function either in combat or in operations other than war. The closer the terrain and the larger the population the greater the requirement for infantry. This requirement has become more pronounced with the increase in operations other than war prevalent today.

As requirements for infantry increase, solutions must be found to meet the future challenges of full spectrum dominance. In some cases, technology can actually expand

the individual soldier's battlespace. In others, such as close terrain and population control, technology can only make the individual soldier more effective; it cannot reduce the personnel requirement for the foreseeable future. A review of current and future infantry systems and their capabilities will reveal some striking future possibilities.

TECHNOLOGICAL DEVELOPMENTS

Incredibly, the infantry appears to be gaining the most from changes in technology and emerging global trends. An examination of research and development efforts clearly indicates it to be one of the most rapidly advancing forces in terms of lethality, mobility and information capability. Technological innovations and mobility combinations with other arms are revolutionizing the future infantry battlefield.

Antitank Weapons

Infantry antitank weapons represent some of the most dramatic advances in capability across the force. The ability of individual infantry soldiers and small crews to destroy armor beyond tank gun range is dramatically changing the combat power equation on the heavy force battlefield. Four air transportable systems; Javelin, Follow on to TOW Missile (FOTT), Line of Sight Antitank (LOSAT) and the Enhanced Fiber Optic Guided Missile (EFOG-M) are slowly changing the open field advantage toward the easily concealed and increasingly lethal infantryman.

The Javelin began fielding in 1996 as part the Force XXI Army Warfighting Experiment (AWE). Representing a tremendous leap ahead capability for the infantryman compared to the M47 Dragon, the Javelin has an integrated day and night sight. Fire control is by passive infrared with a lock on before launch that provides for a

"fire and forget" capability. Either top attack or direct fire modes may be selected for defilade targets. With a 2000+ meter range, and a soft launch capability for firing from enclosures, Javelin represents a tremendous new antitank capability for the rifle platoon.[14]

The TOW weapon system is receiving various missile and target acquisition upgrades as well. Known as the Follow on to TOW (FOTT), the new missile is designed to reach out to about six kilometers with a lock on before launch and "fire and forget" capability similar to the Javelin. Capable of defeating known and expected future threat armor, it will also be capable of overcoming predicted threat countermeasures as well. The TOW improved target acquisition system with second generation FLIR and laser range finder enhance the crew's capability to not only acquire targets but also to overcome misses due to incorrect range determination.[15]

The most deadly direct fire antitank weapon system under development is the Line of Sight Antitank missile (LOSAT). LOSAT takes advantage of kinetic missile technology firing a 170 pound 112 inch long "telephone pole" at 5000 feet per second through an armored vehicle. With a range beyond TOW and a capability to engage multiple targets, this system represents a decided advantage against any known or predicted future tank and antitank missile countermeasure system. Originally designed for mounting on the now defunct armored gun system chassis, it can be mounted on the heavy version of the HMMWV along with a two man crew, giving it an air assault/air mobile capability.[16]

The Enhanced Fiber Optic Guided Missile (EFOGM) is designed to destroy tanks and moving or rotary wing aircraft defiladed by terrain out to 15 kilometers. This system

is HMMWV mounted as well. Like LOSAT, its two man crew and vehicle are air assault capable. Target acquisition is FLIR with GPS inertial measurement for accurate target location, allowing the system to serve as a reconnaissance asset while en route to its own target. With six missiles carried ready to fire and 12 systems planned for a brigade sized maneuver force, EFOGM will give small agile light forces a decided advantage over slower armored units. By interposing terrain obstacles to movement and line of sight between the two forces, the heavy force is completely deprived of its capability to acquire and engage targets.[17]

Directed Energy

Directed energy weapons go beyond the current capabilities of kinetic and chemical energy capabilities to defeat armor. Directed energy uses lasers or high power microwave systems to disrupt enemy electronics and fire control optics in an asymmetrical attack. The weapon strikes at the speed of light at ranges far beyond current or projected tank main guns and is very difficult to defend against without seriously degrading the tank's capabilities. Operating in a scan mode, an invisible laser searches the battlefield for optics. Similar to the way radar reflects back to its source and identifies a target location, the laser detects optics from the human eye or binoculars to tank fire control equipment. In the attack mode it can disrupt these same systems by transmitting a high energy beam, which glazes optics and destroys FLIR systems.

Because it requires only electrical energy to operate, logistical requirements are essentially limited to sustainment of the weapons platform. This could be anything from an infantry fighting vehicle to the individual soldier. While there are ethical issues

associated with the attack aspects of this system (it can cause blindness), its target acquisition role is worthy on its own merits. It can provide precise target locations for both direct fire and, with proper linkage, could conceivably provide the same data digitally to indirect systems. When employed in the attack mode it eliminates the requirement for expensive precision guided munitions altogether. In the detection mode during OOTW directed energy can identify constant surveillance efforts by insurgents and is effective in locating snipers.[18]

Directed energy is not a drawing board item. Two Bradley mounted Stingray directed energy systems were built in 1991 and deployed to Desert Storm (results, if any, remain classified). Two other systems, the Outrider, a HMMWV mounted version of Stingray for light forces, and the Target Location and Observation System (TLOS) were also planned by the Army. However, the Outrider project was canceled.[19]

Scheduled for fielding in 1998 with three systems per rifle platoon, the TLOS could revolutionize the battlefield. TLOS is an M-16 mounted device that detects fire control systems, both optical and FLIR, by using a laser scanner to search the battlefield. Weighing 6.5 pounds, the system can detect at ranges of 2500 meters during the day and 3000 meters at night. The final lighter weight version will have digital integration and GPS and will compute range to target. This system can also destroy these same optics if desired, though current systems have had this capability removed.[20]

The impact of such a weapon in the hands of an individual infantry soldier is tremendous. The fire control system of any armored vehicle or aircraft within sight could be destroyed rendering them useless. Constraints have been placed on this capability by

the Department of Defense, however. There are ethical issues surrounding the use of such a weapon, as it can blind people as well. As similar restraints on the crossbow and gunpowder were not successful, we can expect similar systems to appear in other countries as an effective asymmetrical and cheap counter to our technological advantage in the air and on the ground.

Nonlethal Weapons

Microwave sound weapons transition the spectrum from lethal to nonlethal weapons. Tunable to the desired effect, these weapons create imbalance and disorientation through effects on the inner ear in the nonlethal mode and can incapacitate individuals. With sufficient power, they can cause the internal organs to resonate causing a number of effects including death. The effect on materiel can be equally effective causing sensitive subsystems such as electronics to overheat and melt. Modern vehicle ignition systems, fire control electronics, and communications networks are all vulnerable to this type of attack. Ultralow frequency devices can be directional, tunable and can penetrate buildings and vehicles as well, providing great potential for use in urban terrain. Many of these weapons are already under development, and the challenges of power requirements are rapidly being surmounted. For example, the Russians have already developed a 10 hertz sonic baseball size device that can be tuned for lethal or nonlethal effects[21]. The Army is developing systems as well and has been working on a tunable crew served acoustic weapon.[22]

Nonlethal weapons themselves are a response to the changing requirements and nature of conflict around the globe. Peace keeping missions and humanitarian assistance

are now a frequent occurrence, and combat is more likely to occur in an urban setting where the presence of innocent civilians is likely to demand a reduction in collateral damage. Insurgencies pose another demand for nonlethal technology. The guerrilla's traditional technique of inciting the government to overwhelming force and thereby alienating the population is now at risk. In the future terrorists will find it much more difficult to hide behind human shields, and radical or fanatic groups may be deprived of their much sought after martyrdom through the use of nonlethal weapons.

Current nonlethal developments are targeted at performing a wide range of tasks in a civilian intensive environment where damage must be limited. In built up areas buildings and rooms may be seized with minimal damage through the employment of calmative agents or electric, acoustic or pyrotechnic stun weapons. Crowds may be controlled through the use of blunt impact or malodorous munitions. Individuals may be marked with invisible marking rounds fired (along with many of the other mentioned devices) from the Objective Individual Combat Weapon (OICW) 20mm grenade launcher. Individuals may be secured for apprehension by entanglements or sticky foams and effective barriers created with nonlethal acoustics. Various devices may be employed for seizing or controlling vehicle access as well. Engine kill acoustical or directed energy devices or aerosols as well as antitraction materials can create barriers or assist in the apprehension of those attempting to flee.[23]

Development of nonlethals continues. First deployed to Somalia for the withdrawal of U.S. forces, where only limited use was made of sticky foam, they have since been deployed to Haiti and Bosnia and can be expected to remain on the scene for

the foreseeable future. For the first time the ground commander has the option of a graduated response across the spectrum from lethal to nonlethal depending on the situation. This is not without some complicating factors. For example, rules of engagement are likely to become more complex. U.S. troops could be caught in an ethical dilemma with implications for troop morale as well. With our nonlethal capability to respond to a foe who does not share that capability, our soldiers may die while enemies live and are even subsequently released. Lack of a threat of death could embolden potential adversaries, too. Finally, nonlethal technology could lower the psychological threshold of war, making it a more palatable instrument of policy. Regardless of potential shortcomings and complications, nonlethal weapons provide a flexibility of response previously missing from the inventory.[24]

Mortars

A dispersed battlefield will call for more responsive and increasingly decentralized indirect fires. Dispersion may in some cases limit field artillery ability to respond to lower priority targets, which may have a high priority for engaged units. While this represents no change from current requirements, the infantry's traditional weapon for this mission, the mortar, is undergoing a quiet revolution. With a range of 7,200 meters vice the 5,700 meter range of the Russian equivalent M43, the 120 mm mortar currently being fielded along with future composite mortars which can be fired from a HMMWV, will provide a significant advantage to the American infantryman.[25]

More important than the mortars are the associated fire control capabilities and ammunition. Scheduled for fielding in 2001, the XM95 Mortar Fire Control System

(MFCS) completely integrates the mortar platoon into the Advanced Field Artillery Tactical Data System (AFATDS). For the first time, mortars will be digitally linked to the fire support planning system. Essentially a conversion of the MLRS positioning and guidance system, MFCS reduces mortar setup times from eight minutes to one minute. The crew does not have to dismount to lay in the mortar due to imbedded GPS, which reduces the CEP from 230 meters to 60 meters. Overall, the system provides an autonomous single weapon system capability essentially identical to Paladin.[26]

Enhanced fire control married with precision guided mortar munitions (PGMM) technology represents a deadly combination. Employing an infrared sensor, the PGMM operates in a man in the loop mode for laser target designation or in an autonomous mode where it automatically seeks the largest infrared source in a 500 square meter area (expandable to 1000 meters). With a range of 15 kilometers, the round is capable of precision engagement of armor, bunkers or other high value targets with minimal collateral damage.[27]

Infantry Fighting Vehicles

Infantry forces traditionally exploit any mobility advantage they can obtain. This has remained true from mounted archers to 18th century dragoon and extends to the present day armored infantry fighting vehicle. Today the American Infantryman has available to him the finest infantry fighting vehicle in the world, the Bradley. Scheduled for fielding in the year 2000, the next version of the Bradley, the M2A3, will feature state of the art technology. Complete with second generation FLIR and squad vision displays, this combat vehicle is completely digitized and will be capable of interneting with the

other members of the combined arms team. With enhanced situational awareness, battlefield combat identification capability, and better armor, the M2A3 represents an extremely survivable and effective vehicle.[28]

However, by 2010 the initial production Bradleys will be almost 28 years old. Given the rapidly accelerating technological advances, continued upgrading would not be cost effective. A new vehicle designed to meet the 2010-2015 threat and capable of autonomous dispersed battlefield operations is required. To meet this need, the United States Army Infantry School has developed the requirements document for the Future Infantry Vehicle (FIV).

Designed for greater mobility, the FIV will weigh no more than 25 tons, be transportable by C-130 or airdropped from the C-17 or C-5. Capable of high dash speeds and rapid acceleration, the vehicle would employ advanced propulsion systems (possibly an electric drive) and be fuel efficient relative to current systems. The vehicle will be designed to automatically provide digital fuel and ammunition status to logisticians eliminating voluminous reports, enhancing anticipatory logistics and increasing optempo. Addressing a critical mobility shortfall in the current Bradley, the FIV will be amphibious capable with five minute preparation time. Some unique capabilities such as an autopilot and formation capability are being examined along with robotic control by the dismounted squad.[29]

Although considerably lighter than the Bradley, the FIV will be more survivable. Anticipated as a turretless design, the system will employ composite armor, saving weight, and through low observable technology, provide a significantly reduced visual,

radar, acoustic and infrared signature. Current design criteria specify 30mm or better frontal protection and defense against top attack munitions employing false target generation/jamming or conceivably the Phalanx shotgun type close defense weapon. Stand off mine detection and destruction technologies are to be incorporated providing the vehicle an in-stride breach capability. For the first time an environmental control and overpressure system designed to protect the infantry soldiers from chemical attack will be incorporated as well. For offensive employment the FIV will feature a new on board multispectral smoke system designed to defeat thermal sights. Similar to the Bradley, add on armor will be available as an option for extremely flat open terrain conditions, if required.[30]

The FIV concept represents a significant increase in flexibility by employing both lethal and nonlethal weapons. With acquisition and weapon ranges out to 8000 meters, the system will probably employ a lethal gun (perhaps electromagnetic), fire and forget missile, and laser mix. The system must defeat troops in the open or in trenches (implying microfuzed munitions), destroy threat tanks beyond main gun range while the FIV is in total defilade or moving, and be capable of defeating both rotary and fixed wing aircraft. Advanced target acquisition will allow for multiple simultaneous tracking and precision engagement similar to that of LOSAT. Nonlethal systems are employed for close in self defense, especially in OOTW situations. Finally, the FIV capability to carry an entire Land Warrior squad (9-12 soldiers) represents the greatest increase in lethality over the Bradley, which severely restricts squad size.[31]

Complete digitization of the vehicle further enhances its battlefield capability. Employing a wide variety of integrated electronic sensors, the system will identify threats beyond maximum engagement range and provide warning of threat optical, laser, and radar acquisition and thermal indication of munitions launch, direction and velocity. The FIV must be capable of employing unmanned aerial and ground sensors, NBC alarms, jammers, and perhaps weapons. Built in test and training systems including the ability to download digital mapping and imagery directly from space based or aviation platforms completes a wide range of digital capabilities. Digitization, however, will not be limited to the vehicle.[32]

The Digitized Soldier

As a result of current research and development programs, the lethality, survivability and sensor potential of the infantry soldier is increasing rapidly. Today there are a wide variety of soldier enhancement programs underway. Scheduled to begin fielding in the year 2000, the Army's Land Warrior provides a representative program to enhance dismounted combat capabilities and will be discussed here.

Land Warrior integrates the combat infantryman into the digital "fight" for the first time. The individual soldier is equipped with a small soldier computer and has an individual soldier radio about the size of a cigarette pack with a 700 meter range. A miniaturized GPS receiver combined with the computer and a heads up display allow the soldier to receive and transmit data including preformatted reports, and graphics. The computer contains planning data and other useful information such as target identification pictures and can receive a digital map database to support ongoing operations or future

plans. Potential melding of voice activated communications for message formats and reports may further expand current capability and exploit the tendency to revert to voice communications when in contact.[33]

The infantryman is protected by Modular Body Armor (MBA) which provides protection against fragmentation equal to or better than the current vest and includes protection of the front and back torso from small arms rounds and flechettes.[34] Improved NBC protection is under development with experimental masks and NBC suits separate from the Land Warrior program. Fratricide avoidance is enhanced by a Combat ID Soldier System (CIDSS) which employs an eyesafe dual purpose interrogator and aiming light for soldier to soldier identification at ranges out to 2400 meters.[35] Low observable technologies to reduce soldier signature have been examined but are not currently funded as part of Land Warrior.

A number of additional initiatives have also enhanced the infantry soldier as a first class sensor in all environments. In particular, "own the night" image intensification improvements, soldier thermal weapon sights, laser based target acquisition and video transmission capabilities will likely have a tremendous effect on future tactics. The battlefield is likely to become much more deadly for the enemy regardless of terrain or visibility conditions.

The own the night effort was initiated at the Army's Dismounted Battlespace Battle Lab based on a 1991 Chief of Staff directive to maintain the Army's edge at night. The focus of effort has been the improvement of night vision equipment at the platoon level. Significant progress has since been made. Employing third generation (GEN III)

image intensification tubes, experimenters were able to obtain a 25% increase in capability over current systems. Some simple devices such as inexpensive clip on three power magnifiers tripled the effective target acquisition range to beyond 1000 meters. When coupled with laser aiming lights, the combination was deadly. Current fielding plans include either a GEN III night vision goggle or monocular device for every soldier and magnifiers for leaders.[36]

Own the night initiatives included a large number of supporting devices as well. For example, infrared 40mm, parachute, trip and pen flares and small hand held laser pointers were developed or acquired to assist in locating targets and directing squad fires. Compact blacklight markers that can be remotely turned on and off assisted in marking landing zones, and a wide variety of infrared devices assisted in controlling difficult night breaching operations.[37]

Fielding began last year on one of the latest and most effective own the night initiatives, the thermal weapon sight (TWS). Weighing five pounds or less, depending on which of two interchangeable optics are employed, TWS is a day/night sight with a range of either 1100 or 2200 meters. This sight has a number of advantages over image intensification devices in that it can see through smoke and fog and is not dependent on ambient light. This allows for the employment of smoke at night to deprive threat forces with earlier night vision devices of their capability.[38]

A spin off effect provides the individual soldier the capability in operations other than war to scan personnel for "cold spots" indicating a concealed weapon. The TWS also provides a standard video feed that can be linked to the digitized soldiers helmet

display allowing him to fire the weapon from defilade while observing his target. While currently linked by a small video cable, efforts are underway to develop a transmission linkage, deleting the cable. This particular sight, due to its unique capabilities, is envisioned as the principle sight for the next generation of infantry weapons.

The individual soldier's weapon is the bread and butter of close combat. While the Land Warrior program is built around a modular weapon system, current planning envisions a family of lightweight future weapons with an all weather day and night capability. With twice the range of current rifles, the Objective Individual Combat Weapon (OICW) will feature a bursting 20mm automatic grenade launcher capability based upon revolutionary microfusing technology in addition to a kinetic energy round. The miniaturization of the fusing allows the individual soldier to engage defiladed targets out to maximum range.

With a 90% probability of incapacitating a target at 500 meters compared to the M16A2's 15% probability, the OICW has a maximum effective range of 1000 meters with a 50% probability of hit. At the same time it weighs less than the M16A2 and will begin replacing not only the M16A2, but the M203, the M4 carbine and the M249 Squad Automatic Weapon by 2006. Equipped with a laser range finder, the OICW represents a radical departure from old iron sights fire control.[39]

The Advanced Medium Machine Gun will replace the M60 by 2015. Incorporating day/night full solution fire control and firing kinetic energy linkless ammunition, it will weigh only 22 pounds complete with tripod, fire control and ammunition. This represents a drastic reduction from the 120 pound load of a complete

M60 Machine Gun with tripod, spare barrel, AN/PVS-4 Night Vision Sight and binoculars with 800 rounds of ammunition.[40]

The Objective Crew Served Weapon (OCSW) scheduled for fielding in 2006 is essentially a 25mm grenade machine gun which fires either HE or HEDP ammunition. It will be capable of defeating light armor out to 1000 meters and incapacitating and suppressing protected personnel out to 2000 meters. Weighing with tripod and ammunition essentially the same as an M60 machine gun, it will be portable by a two man crew. Intended to replace both the MK19 40mm grenade launcher and the M2 .50 caliber machine gun, it will be at least three times more effective than either based upon weight, ammunition effectiveness and fire control.[41]

Technological Impact

Infantry force versatility has taken a quantum leap with technological advances. Fully digitized infantry, paired with aviation or light composite combat vehicles for mobility, with precision artillery and attack helicopters for firepower and with its own organic weapons capable of rapidly defeating modern armor and aviation, will soon be capable of dominating the open terrain fight.

The individual soldier can now operate more dispersed but with equal effectiveness in many if not all terrain conditions. He can win against a wider variety of targets than in the past and will be much better equipped to deal with the special infantry type challenges associated with urban combat or operations other than war. At the same time there are other implications not only for the infantry soldier but necessarily for the force as a whole.

IMPLICATIONS FOR THE FUTURE

FORCE STRUCTURE

The characteristics of accelerated technical change combined with the emerging strategic environment and domestic affairs have set the conditions for the resurgence of infantry. The development of force structure to meet competing requirements must exploit the inherent capabilities of the nation and create a robust and flexible armed force capable of executing its assigned mission at minimal cost. This requires the maximum use of existing industrial base assets including research and development. Industries that remain strong in spite of defense cutbacks offer the most promise, generally manufacturing small items for consumer use and funding their own research and development. Such dual use technology is usually less expensive, periodically upgraded by a competitive industry, and can be rapidly mobilized in a crisis due to the existence of production facilities and a skilled work force.

The general lightweight nature of dual use technology from the industrial base is most applicable to light forces in general and the infantry soldier in particular. This allows these forces to be rapidly and constantly modernized at relatively low cost. Other systems are slower to modernize and more costly due to special production requirements and hence risk obsolescence by production time. Large, low density high dollar systems with long lead times are even less cost effective if examined in the light of cross spectrum utility and actual employment. Many of these systems require long term specialized training to qualify personnel on their use. Special purpose pay and grade requirements further increase the cost. Land forces, particularly light ground combat units, offer a

greater return for the modernization investment. This is not to say that other forces are unnecessary. They are valuable, but they are less easily modernized and less flexible across the spectrum of conflict.

ORGANIZATIONAL REQUIREMENTS

Historically, revolutions in military affairs have coincided with multiple transformations in mobility, lethality and information capability. This, combined with timely adaptation of tactical or operational systems, generally resulted in greatly enhanced capability to dominate time and space. The most dramatic example of this is probably the blitzkrieg, combining the mobility of the tank, the ability to transmit information via vehicle mounted radio, and the concept of close air support into an operational system designed to disrupt rather than directly attack enemy defenses. Achieving such a dramatic transformation today, given the accelerated pace of technological change, poses a tremendous challenge. Strategic, operational and tactical victory will belong to the side that can develop organizations with a superior combination of mobility, firepower and information capability at each level. On the other hand, single facet dominance lacks depth and flexibility and is a recipe for disaster.

The Decentralization of Arms

Today we are witness to a merger of the levels of war from tactical to strategic. Levels of intensity are merging as well, and as they do, many roles and missions are changing and being consolidated. Aviation is assuming the traditional role of cavalry based on its mobility and information gathering capability. Artillery is rapidly developing the ability to fix through precision munitions, and along with aviation, is

rapidly becoming the biggest tank killer on the battlefield. Armor, no longer in sole possession of a mobility advantage, is better in a position of a fixing force rather than in exploitation. The infantry has become one of the best disrupters on the battlefield, a traditional artillery role. By virtue of its unique capability to combine its foot mobility with that of the armored vehicle and aircraft, it remains the most versatile of arms, capable of all its traditional roles as well.

Tactical systems which exploit technological advances which have generated these changes generally demand revisions to organizational structure. Units capable of rapid concentration to attack and speedy dispersal to avoid destruction are neither large nor rigidly designed. The best approach to achieve this goal is to combine differential capabilities in the same unit at the lowest possible echelon. This represents the fundamental principle of combined arms, placing the enemy on the horns of a dilemma and leaving him with defeat as his only option. The fundamental truth of this statement is born out by the increasing trend toward lower echelon combined arms organizations and joint teams driven by dispersion and the need for flexibility.

Highly mobile, dispersed units will require that mobility assets be assigned to the lowest possible unit requiring constant use. High optempo operations mean organic assets. Units cannot wait for transportation on a dispersed battlefield. The evolution in the original fielding of early armored personnel carriers as a division or regimental asset down to the level of a squad organic carrier clearly demonstrates the utility of this approach. It is conceivable that the assault helicopter may one day follow this same path.

Dispersion, mobility and vast improvements in precision fire control and communications argue for a decentralization of artillery as well. We have reached the time when individual artillery vehicles on the move can receive, process and execute a fire mission in one minute. This capability for dispersed yet responsive artillery operations is unique to the American Army and provides the best possible defense against counterbattery fire.

In the dispersion characteristic of expanded battlespace, reconnaissance efforts are directly affected by a geometrically expanding security zone. Aerial reconnaissance is required at brigade level. Vehicular mounted ground cavalry cannot cope with rapidly shifting requirements of a nonlinear battlefield unless they are transportable by aviation. A combination of UAVs, rotary wing aviation and ground cavalry with vehicles which can be slung under assault helicopters provides the most likely answer to this challenge.

The logic of dispersed operations argues for versatility and general application across the spectrum of conflict rather than the limited specialization envisioned by some authors. Those who draw conclusions about military organizational principles based upon civilian business and industry have fallen into a false analogy. While individuals may possess a particular expertise, units must be flexible implying versatility, not specialization. The balance of versatility and specialization must be struck at the lowest possible echelon in order to achieve flexibility.

Currently that level is the brigade as a fixed (though not by TOE) organization with multiple arms assigned in battalion strength and supporting units attached for field operations. Assigned combat arms units are subsequently task organized at battalion task

force and company team level. The dispersed battlefield may force a lower level of permanent assignment, grouping combat support and combat service support units to the brigade and forming more permanent task forces at lower echelons. This concept has been promoted for some years by armor proponents, primarily as a tool to gain more armor positions. The infantry community has steadfastly resisted this concept, though the time may be approaching to reconsider, as dispersed operations will inhibit changes in task organization.

The Role and Structure of Echelons

Echelon structure itself can be called into question here. Organizations are structured to support the will of the commander. A more dynamic battlefield requires more responsive organizations. Historically, echelons have balanced the recognized limitations on communications capability and span of control of three to five subordinate units with the requirement to consolidate limited special assets at the lowest possible echelon commensurate with their availability and required responsiveness. Digitization and communications improvements have dramatically changed the first two limitations. The net effect bears a striking similarity with 18th Century battlefield command and control.[42]

With almost complete visibility of his own formations and with reasonably good visibility of the enemy, the senior commander's requirement for intervening layers of command is reduced. The feasibility of a flatter organization has a number of positive benefits. A shorter chain of command due to better situational awareness allows for a more rapid transmission of orders and a faster decision cycle. It also solves one of the

potential problems of digitization. A wider span of control permitted by better visibility will prevent leaders from becoming "squad leaders in the sky", retaining the spirit of initiative at each successive echelon.[43]

The Heavy Infantry Force

When the previous considerations are applied, it becomes apparent that heavy mechanized land forces have lost the mobility differential they were created to provide. The sheer bulk and weight of current combat vehicles limits strategic, operational and tactical mobility in all but the most carefully prepared logistical scenarios in the most benign terrain environments. It is possible that many armored vehicles of today could no longer cross the World War One battlefields they were originally designed to overcome.

Additionally, tremendous support requirements further limit tactical and operational mobility required of a dispersed battlefield. Road bound equipment and supplies, especially fuel, provide not only lucrative targets but a critical vulnerability as well. It is highly unlikely that the sweeping armored maneuvers of World War Two could be performed today due to rapid logistical culmination. The more difficult challenge of dispersed operations is clearly beyond the reach of current heavy organizations.

Modern mechanization comes with a high CSS price in diverted manpower as well. Large numbers of potential "warriors" have been diverted from combat to logistical tasks. One of the principle reasons for reduced casualties on the modern battlefield is not necessarily better medical support. The "tooth to tail" ratio for mechanized warfare has grown so tremendously that, while casualty percentages at the tip of the bayonet have

remained relatively constant (around 80% of total combat casualties are infantry), the overall casualty percentage has steadily decreased.

All these constraints place a ceiling on combat potential of heavy forces as currently configured. Recent digitization efforts represent an attempt to enhance overall combat power by information dominance, tacitly recognizing in the process that the current weight of logistics and armor plate have stymied mobility and that the lethality of line of sight weapons has reached culmination. Certainly radios would have helped make horse cavalry more effective as well. Yet, the greatest payoff for the digitization effort lies in organizations that can increase mobility and lethality as well as information capability. Therefore, without changes, this force is at greatest risk to asymmetrical defeat and destruction in future war.

Nevertheless, heavy force enthusiasts continue to quote J.F.C. Fuller and Liddell Hart in support of their arguments for continued dominance of the heavy tank on the modern battlefield. This is wisdom out of context. Hart and Fuller did the majority of their work in the days before the advent of rotary wing aviation as a combat force. Further, Hart in particular was an advocate (along with MG F. W. Von Mellenthin, Rommel's chief of staff[44]) of light, fast, easily sustainable armored vehicles in the post war era.[45]

The future of mechanized infantry rests in a lighter more flexible organization whose combat power is derived from information dominance combined with significantly increased lethality and strategic, operational and tactical mobility coupled with reduced logistics/sustainment requirements. Mechanized infantry must be capable of both

mounted and dismounted combat in conjunction with or completely separate from the future infantry vehicle and must have sufficient infantry to operate in close urban terrain or to execute military operations other than war. It must once again be capable of conducting separate dismounted maneuver or of merging differential mobility characteristics to conduct high optempo maneuvers such as air assaults.

Dispersion and the requirement for separate dismounted operational capability will mean that the future mechanized company must have its own organic weapons for air defense and indirect fire. Additionally, light, autoloading, rapid fire expeditionary tanks with the ability to acquire and engage multiple targets on the move will be necessary to round out any future mechanized force. The heavy tanks of today cannot meet future requirements of a force projection Army.

Although weight reduction and decreased logistical requirements will make mechanized units more agile, sustainment must still be accomplished. Contrary to current trends toward centralization, cellular logistical organizations established at company level will be essential to sustaining combat operations. The current Force XXI centralized approach at a division support command and brigade level with all CSS assets removed from battalions cannot work on a widely dispersed battlefield. If anything, managerial duties at higher echelons have been simplified by information technology to the point of bringing commands at this level into question.

In summary, the future mechanized maneuver unit will require a near permanent combined arms team preferably at company level, but certainly at battalion. Savings in managerial and crew manpower gathered from technological advances must be reinvested

toward recouping lost infantry strength critical to success on the expected battlefields of the future. Finally, because mechanized forces require longer lead time to transition equipment due primarily to cost, the changes in equipment, organization and doctrine need to begin soon. Ideally, as we approach the block wear out dates for the major end items of the current heavy force, we will be prepared with a more agile and lethal replacement organization.

Light Infantry Forces

Today's light forces represent the best trained light infantry in the world. Designed for the low end of the spectrum of conflict they are strategically mobile and require minimum sustainment. However, as with today's heavy units, America can no longer afford extreme specialization of ground combat forces. While some variation is useful, both forces must have a potent capability regardless of mission. Light units, therefore must be capable of highly successful combat operations against a modern mechanized force regardless of terrain. This capability can be achieved through structure and equipment changes and through innovative asymmetric approaches to tactics discussed later.

Current light forces will achieve tremendous advances in effectiveness through digitization. Situational awareness has always been critical to light infantry. Without the capability to extricate itself from danger through superior mobility or to defend itself with massive firepower available to heavier forces, light infantry commanders have excelled at detailed planning and preparation for tactical operations. The absolute requirement to get it right the first time or lose a significant number of lives in the process has created a

culture of deliberate, methodical operations. Conversely, this same cultural aspect has slowed the tempo of light force operations to a crawl, even when merged with the powerful mobility advantage of an air assault task force. Digitization and greatly improved situation awareness should increase the tempo of light operations considerably within certain limits.

Lack of organic tactical and to a lesser extent operational mobility will still restrict the pace of light force operations unless the structure is changed. Maneuver by muscle power can only provide a limited battlefield footprint without exhausting the principle weapon, the light infantry soldier. To overcome these shortfalls, tactical mobility must be reintroduced to the light division structure. This may be accomplished through either the introduction of ground or aviation lift capability. Both concepts have proven valid in the past.

The single motorized division employed by the Army as a developmental test bed, proved exceptionally flexible in operations at the NTC. Unfortunately, this concept did not receive a chance at combat validation in Desert Storm, where it may well have heralded a future path for the current heavy force. While a versatile organization on the desert floor and certainly more agile than a heavy force, the motorized concept begins to lose its mobility as terrain becomes more restrictive. The ideal answer to light infantry mobility problems is free from terrain restrictions.

The only organizational concept designed to retain the training flavor of light infantry and yet provide the tactical and operational mobility required of the modern battlefield is the air assault concept. This dynamic result of combining infantry, artillery

and aviation has proven itself valid across the spectrum of war. From Algeria and Vietnam to the Falklands and Desert Storm, the merger of infantry foot mobility and the speed and obstacle crossing capability of the helicopter have proven to be a terrific combination. In close terrain the attack helicopter served as a direct fire support weapon for the infantry, while the infantry found the enemy for indirect fire support. In open terrain the infantry served to secure and support attack helicopter operations similar to the support he has traditionally provided to the tank.

Today's aviation allocation to light divisions is inadequate for the fast paced operations of the future. Battlefield agility across the spectrum must be enhanced if tomorrow's force is to really achieve full spectrum dominance. Small highly mobile organizations with exceptional long range nonjammable communications and rapid cross country speed (both operational and tactical) can dominate a wide variety of tactical situations. Conceivably, future structures will provide aviation at increasingly lower echelons, eventually replacing the air assault concept with one of air maneuver.

The final weakness of light infantry organizations is their inability to successfully engage armor except in very restricted terrain. The technology is rapidly being developed and fielded to correct this. Even now, the Javelin is choking off mobility corridors once considered easy access by the OPFOR at NTC[46]. To achieve full spectrum utility necessary for a small army, the light infantry antiarmor capability must be fixed. This means increasing the number and variety of weapons available. The TOW antiarmor platoons currently in the light structure are completely inadequate. Provision for an EFOGM battery at brigade level along with the return of a HMMWV mounted LOSAT

antiarmor company at battalion level will eliminate this dangerous shortfall, especially when combined with the fielding of precision guided mortar munitions.

A rapidly deployable modular light infantry force package capable of cross spectrum dominance is not difficult to design. Combinations of highly deployable and lethal RAH-66s, HMMWV mounted LOSAT and EFOGM antitank systems and digitized infantry armed with new weapons are on the horizon today. Employed in an air maneuver role and capable of targeting mobile armored formations with precision artillery delivering brilliant antitank munitions, such a force could be the most lethal organization ever to operate on the open battlefield. Rapidly deployable by either C-17 or C-130, this force would represent a tremendous increase in capability over both current light contingency forces and ponderous heavy units. This same organization, task organized differently, would be equally as effective in urban and low intensity operations, where precision and mobility in restricted terrain are equally important.

The Infantry Squad

At the lowest echelon, the squad will remain the building block of infantry units regardless of type. The traditional parameters that have limited squad size are expanding. Previously, dispersion of the squad was restricted by the range of voice communications. Individual soldier radios and GPS along with soldier computers, which can provide automatic location updates, increase the command and control capability of the squad leader and the situation awareness of his subordinates. Even individual soldiers may find themselves dispersed 50 to 150 meters depending on terrain conditions

This capability matches with the increased firepower capabilities of the squad. With individual combat weapon ranges of 1000 meters, squad level antiarmor capability with Javelin of 2000 meters and the digitized ability to call and have precision guided indirect fire on the way in 60 seconds, the squad can dominate the same terrain as yesterday's rifle platoon. Firepower of the squad is no longer dependent on the number of riflemen.

These changes dictate the requirement for a new squad study. The last such research, the Infantry Rifle Unit Study (IRUS), was conducted in 1969. Employing various combinations of from no fire teams to three and numbers of soldiers from seven to sixteen, this study reached several important conclusions. First, for ease of control two fire teams, each with leaders, was the best organization for the infantry squad. Second, each squad should have an organic machine-gun for additional firepower. Finally, squads of eleven and thirteen men consistently outperformed smaller organizations, especially in close terrain situations where smaller organizations rapidly became ineffective due to

attrition and compartmentalization. Many of these results confirmed earlier testing in 1956 and 1961.[47]

The genesis of the current nine man squad of the U. S. Army leaves much to be desired. The 1946 Infantry Conference at Fort Benning, Georgia provides the only real justification for this organization. This conference examined, among other issues, possible revisions of the World War Two twelve man rifle squad. Attendees operated on two key assumptions. First, the squad should consist of only as many soldiers as a single leader could control, and second, it would not engage in separate fire and maneuver as mutually supporting teams, but operate as a single unit within the context of platoon fire and maneuver.[48]

Conference members determined that the number of soldiers to execute this concept was about eight plus the squad leader. Additionally, based on their wartime experience, the squad should be capable of absorbing 25% casualties and still remain functional. Subsequent studies of wartime operations have determined that separate team employment in supporting fire and maneuver is impossible once squad size drops to seven men. Hence a nine man organization has little hope of executing current squad level fire and maneuver doctrine.[49]

The ultimate adoption of the current nine man squad has no warfighting basis. When the Army decided to adopt the Army of Excellence and create new light divisions it came up short in personnel strength. This shortfall was made up in part by the reduction of nonmechanized squads from eleven to nine men. Similarly, Bradley infantry was constrained based on carrying capacity of the vehicle, not infantry combat

requirement. Given peacetime manning and wartime attrition, effective training and combat operations appear to be at risk with this organization, especially when dispersion is considered.[50]

Intuitively it seems that the infantry squad needs to increase in size given technological advances and the nature of the future battlefield. However, this decision needs to be made on the basis of scientific analysis, not opinion. It certainly does not need to be made based on a requirement to reduce force structure or make personnel slots for some new requirement elsewhere.

DOCTRINE AND TACTICS

New capabilities will drive new tactical requirements, as well as organizational initiatives. A doctrine of tactical dispersion based on greater information, mobility and lethality is on the horizon. For the infantry this will require mobility for positional advantage at decisive points combined with a tactical defense employing sensor to precision shooter linkage at every echelon.

On the open battlefield, this mobility and defensive strength will combine with asymmetric weapons and tactics. The asymmetric attack of electronics and optics with directed energy weapons reinforces the new role of the infantry soldier as more than a rifleman. The artillery concept of indirect fire required linkage with an appropriate information system for success. Today that same concept has been applied to the Apache Longbow system through digitization, allowing the Apache to engage multiple targets from defilade. Future infantry will be able to apply the same tactics.

With automated fire control and near instant fire delivery, each infantryman will have at his disposal the firepower of an artillery battery of precision munitions capable of much closer and more responsive fires than in the past. Non-line of sight antiarmor weapons will achieve protection through the use of intervening terrain. This indirect fire from defilade can be applied all the way down to the individual soldier and his weapon with its thermal video feed capability further increasing the infantry soldier's survivability and lethality.

The original importance of the "high ground" will change as well. It may no longer be significant except for observation by small groups of dispersed infantry soldiers or as a shield to prevent suppression and limit threat mobility. The requirement to retain terrain diminishes as the disruption and destruction of the enemy in an expanded fluid battlefield becomes the focus of operations. Greater situational awareness and certainty will diminish the traditional requirement for a reserve as well.

Close terrain operations will be more traditional. Unfortunately, technological advancements cannot reduce the manpower requirement of infantry for close terrain situations. Infantry poor units have proven extremely vulnerable in close terrain situations in the past, regardless of other capabilities they may have possessed. Light infantry troops in large numbers will continue to be required to seek out the enemy and provide target information and intelligence and to bear the brunt of combat operations

Precision and mobility will apply as well to the close terrain fight, and information technology will greatly assist operations. Some increases in dispersion will occur, modifying small unit tactics and requiring greater independence on the individual

soldier's part. However, current and expected sensor capabilities will not allow the same degree of threat situational awareness available in open terrain.

LEADERSHIP

New organizations and tactics will require even better leadership at lower echelons. Dispersed and independent operations of small units will require the caliber of leadership and reliability normally expected of the officer corps. This will further enhance the already strong role and prestige of the noncommisioned officer in the American Army. Increased technical aspects of military operations will make it more difficult than ever to retain quality noncommisioned officers, especially in an era of a strong economy. This will demand an increase of benefits commensurate with enhanced responsibilities.

Soldiers are affected by leadership. Machines are not. Even today there exists a disparity between grade and pay versus leadership requirements and responsibility. In a military institution where all specialties are technical a more balanced approach between benefits and responsibility is necessary. The current rifle squad costs the government as much as a high performance aircraft over an equivalent life cycle and requires much more skill to lead under peacetime conditions, much less the stress of close combat.

The tradition of an officer requirement for a single aircraft or for a senior noncommisioned officer in command of a single combat vehicle must be reexamined. An actual comparison of risk, responsibility and pay would be embarrassing, especially considering that information technology and robotics are rapidly eroding the requirement for manned platforms. Traditional approaches based on elitism are no longer relevant.

Because of increased span of control, the future noncommisioned officer corps could be smaller, allowing more flexibility for better pay and enhanced privileges and benefits. The gap in rewards for those that influence people and those that only control machines must be closed, especially if both must possess considerable technical competence as well..

While the NCOs will become the specialists, the officer corps will require more generalists capable of commanding combined arms units at lower echelons. This represents a refutation of many futuristic visions of increased specialization. With increased skill expected in the employment of all arms at a lower grade, merger of branches may be necessary at field grade into a maneuver specialty rather than the current combat arms system. Retention of skill identifiers would assist in providing the proper mix of experience in combined arms battalions by alternating specialties in the command group. This only represents tacit acknowledgment at a lower echelon of what occurs today in heavy brigades, where the second in command is a different branch from the brigade commander.

The increased span of control derived from better situational awareness brings several associated issues. With increased span of control at each echelon and fewer echelons, the leadership ratio is obviously diminished. This creates a flatter pyramid for upward mobility in both the officer and NCO corps with the associated issues of opportunity for promotion and increased pay. This may require shorter careers and a revision of the military retirement system.

At the same time, a short career must be made attractive through enhanced pay and benefits such as education, retraining and separation options. Another option could be an expansion of officer candidate opportunities vice other commissioning programs. One of the traditional reasons for maintaining a separate officer and NCO structure has been the time required to advance through the ranks. With fewer echelons and an increasingly higher standard for NCOs, a merger of the leadership structure is possible, though highly controversial..

A final issue concerns the development of daring and resourceful leaders. Dispersion and greater span of control has the potential to result in less personal contact with soldiers. At the same time, information technology has the negative potential to develop a quest for certainty. It becomes more difficult and less necessary to "troop the line" for an actual look at the situation and to show solidarity with the troops.

Leaders accustomed to this environment risk becoming psychologically frozen when deprived of situational awareness and emotionally out of contact with their soldiers as well. This represents one of the principle dangers of overreliance on information technology. It can give the commander a false sense of the battlefield, and has the potential to alienate the chain of command from the fighting soldier, whose respect for leaders is based on their competence and willingness to share the hardship of the battlefield. Selection and careful training of leaders along with provisions for their battlefield mobility are the answers to this dilemma.

THE INFANTRY SOLDIER

The word "warrior" is the most frequently abused label in the current military lexicon. Most if not all who wear a uniform view themselves as warriors. In reality there are very few who qualify. This does not diminish the contribution of all service members. At the same time, more precision is required as to who can actually be considered worthy of this title and what the prerequisites are in terms of risk and attributes both now and in the future.

A warrior is one who places himself at great risk to engage in direct combat with the enemy. Simply being at risk is not enough. Generally speaking, where the casualties may be found, there will also be found the warriors. This criteria eliminates a significant majority of the nation's military structure and indeed, large parts of the Army. Even within the combat arms there are greater and lesser degrees of worthiness. It is not difficult to argue that, as a group, the infantry represents the largest warrior element in the armed forces. Always at the most personal risk and with the least protection, he offers battle to his enemies on an individual, personal and sustained basis.

Even within this group, the warrior ethic is not all inclusive. SLA Marshal was one of the first American military writers to recognize that relatively few infantrymen actually fired their weapon in battle. By his research, only 15 to 30% of World War Two combat infantry soldiers ever actually fired their weapon in an engagement. This contention was verified in postwar articles by infantry unit commanders who stated that in any given engagement, you could count on certain soldiers to actually aggressively

engage the enemy. Others, who were willing to share the danger, did not necessarily fight. Asked to repeat his study in Korea, Marshal found the average up to 50%.[51]

Although Marshal's findings have been hotly debated for years, numerous other scientific studies in the Korean War determined that there were certain characteristics of fighters and nonfighters, which could be easily identified in advance. Significant among the required factors were a higher order of intelligence than the nonfighter combined with leadership ability, outdoor orientation, emotional stability and a sense of humor. All factors were clearly observable through personality tests, which could be administered prior to selection for a military specialty.[52]

This research has significant implications for the future infantry force. The high-tech land warrior of the future requires a greater degree of resilience than his predecessors. Stress on highly mobile units is likely to be increased due to their more frequent employment in combat. With increased dispersion, the requirement for self imposed discipline becomes higher, and a greater premium will be placed on self reliant initiative and the ability to operate for extended periods alone or in small groups. All soldiers on the future battlefield must be mentally capable of firing their weapon.

This argues for psychologically and physically stronger infantry soldiers requiring the best physical, mental and moral traits the nation can offer. No longer can the infantry soldier be relegated to a lower priority for quality recruits. To achieve the goal of every man a fighter requires psychological screening and conditioning. This same method is applied today to the selection of special operations personnel, who must consistently operate in an environment similar to the dispersed battlefield of the future.

Two other characteristics must eventually be applied to the individual infantry soldier. First, there must be age limits for enlistment into an infantry specialty. Infantry is a young man's game. With age comes loss of the physical ability required to operate at platoon level. Second, if possible, the individual combat soldier should be single. There are a host of reasons for this. The higher operational tempo of a smaller force structure could be better managed with less soldier stress and therefore better focus during extended training or deployments. Psychological tests of fighters and nonfighters from the Korean War show a direct correlation between nonfighters and combat soldiers with dependents[53]. This is not politically correct but it is true. Soldiers with conflicting loyalties between commitment to the squad and responsibility for providing for dependents are less likely to expose themselves.

A single soldier criteria will be difficult to meet. However, given adequate compensation, the right quality can be recruited and retained. This same criteria could even allow more money for soldier pay, as the cost of maintaining junior enlisted dependents would be greatly reduced. To make the option of joining with a limited possibility for upward mobility into the NCO ranks attractive, enhanced opportunities for post service education or employment must be offered.

In a small military those who endure the harshest service should be offered the most compensation. A gratis educational scholarship program combined with thorough screening would have the advantage of attracting more of the desired candidates for infantry as well as providing sufficient motivation to leave the service after an initial term. Interestingly enough, the best trained and disciplined light infantry represented by

the Ranger Regiment already experience this as a natural process. Most Ranger first termers leave the service for college having saved the required amount of matching funds to complete a degree.

Manpower

The previous requirements for quality must be applied to the expected battlefield. The only nonlinear wars that we have fought in the past have been counterinsurgencies. These conflicts have always been infantry intensive. The requirement for infantry on the dispersed nonlinear battlefield of the future will be no less. In fact, demands for infantry protection of CSS and combat support units during division level BCTP Warfighter exercises always exceed capability, drawing strength away from the fight. The increasing probability of urban operations magnifies this requirement.

If infantry is the most employed and most capable of arms it also the most frequently expended. Casualty statistics for infantry have remained relatively constant. While overall casualties have been reduced significantly, the infantry percentage has remained around 80% of the total.[54] While dispersion, new tactics and better individual protection from body armor and stealth technology may reduce these figures, we can still expect the infantry force to sustain the bulk of casualties in future war. In fact casualty losses by branch provide a clear indication of the depth required to sustain lengthy combat operations. By some calculations, there is insufficient infantry strength today, active and reserve, to repeat a successful defense of South Korea.[55]

Infantry shortages in close terrain combat have historically led to cannibalization of other units to provide the required ground strength. This occurred in both World War

II and Korea. Operations in Somalia, Haiti and Bosnia have highlighted the great shortages of infantry strength in heavy units deployed to these regions; nondeploying units were stripped of infantry to fill positions in participating organizations. This is not surprising as the current mechanized infantry platoon only has two nine man squads, two thirds of its light component and only one half of previous wartime organizations. Similar shortfalls in forces of the former Soviet Union in Afghanistan and Chechnya dramatically highlight the risks of infantry poor units in combat.

This problem becomes magnified on the future battlefield. More mobile units are more frequently engaged resulting in more casualties over time. Although their casualties per engagement may be fewer based on their ability to choose and strike the enemy's weak spots, the cumulative effect may be greater. At the same time the human "machine" requires time to recover from the stress of combat. A scientific medical analysis of infantry units in Korea under various combat conditions from light to heavy provided a clear indication of the time required to regain full human combat potential. The more intense the combat the longer the time required.[56]

This finding implies serious consequences for attempting to do more with less in infantry close combat. No other arm bears the psychological and physical burden of the infantry soldier. Men are not machines and they must be sustained differently or they will eventually fail. Aside from reduced combat effectiveness, the results of repeated commitment to combat without recovery time include a greater propensity to commit atrocities, a serious political consideration given the global information environment of future war.

Current Army infantry strength represents only 11.4% of the active component and 10.4% of the reserves.[57] This is an amazing situation given the wartime and low intensity requirements for infantry. In a long war or two major regional contingency scenario, especially one requiring reconstitution of units, this manning strategy will create significant problems. The ability to mass produce combat infantry soldiers departs with the increase in required technological competence. A larger infantry component is required to meet the challenges of future conflicts. This does not require an increase in force structure. Manpower savings in crew reductions due to automation and a reduction in clerical and enlisted staff requirements must be reinvested in infantry strength.

TRAINING

Training represents the single greatest challenge to the future infantry force. The infantry soldier must be trained to operate in small groups or as individuals for extended periods. Mass can no longer be used to inspire confidence. While initial soldier selection will help, the new recruit must be conditioned for the additional stress of new forms of combat. This requires a more demanding basic and advanced individual training program than is currently employed. The internalization of soldier values must become a component of training as well. Only the crucible of a combined selection and conditioning process can provide the product required for decentralized operations.

Overall, essential technical training for the digitized soldier will also require a longer training program than that currently employed. As a result of dispersion, the individual soldier may be required to perform additional skills previously done by another specialty. Employment of indirect fire and selected engineer tasks will become

critical to the infantry soldier of the future as there will be insufficient artillery forward observers or engineers to accomplish all missions. Close combat skills cannot be neglected and must remain the core of individual training. In addition, the training base must turn out a fully, as opposed to a partially trained soldier. Units will have their hands full responding to sustainment training for an increased number of tasks and adapting training programs to rapid changes in doctrine, tactics, techniques and procedures.

Accelerated technological change will outdate many techniques and procedures within a relatively short time. Lack of a monolithic enemy with a set doctrine, as in the cold war, complicates matters as well. While doctrine and tactics can be developed within one to two years to keep up with these changes, internalization of new doctrine into the force is much more difficult. Incremental modernization of the force will create its own challenges. Requirements for top to bottom retraining of units in the field will demand innovative solutions. Distance learning provides one alternative for rapidly disseminating new doctrine. This will require changes to institutional structure and some adaptations of the battle focused training approach.

First, the institutional Army must be resourced to develop and produce the required distance learning materials. Resourcing for adaptive production currently does not exist in TRADOC. The severity of personnel shortfalls is reflected in the inability to produce revisions of soldier training manuals to keep pace with today's modest modernization effort. Without due consideration to resourcing training development, the CD-ROM distance learning materials of the future will follow the road of the training extension course (TEC) tapes of the past.

Contracting for production is an option. However, this approach requires so much work in oversight and review that it really is not cost effective and generally results in exorbitant fees for a minimum standard product. The best solution is a revitalization of personnel authorizations for training developers and doctrine writers using spaces formerly allocated to production, now almost completely automated.

An additional way to increase quality and decrease production time is to standardize squad and dismounted platoon elements across the force and to focus on basics. While infantry forces possess a common mission and associated tasks required for successful employment, they may be deployed strategically, operationally or tactically by a variety of means. Care must be taken to distinguish between means of delivery and means of employment.

There exists a false theory of specialization by means of delivery. This undermines the essential character of infantry, defined by its role on the battlefield. The impact of this myopic concept is a general dilution of emphasis on basic infantry tasks and increased emphasis on tasks associated with getting to the place of employment. In a training resource constrained environment this specialization concept is dysfunctional at best and siphons away minimal resources from the main effort, infantry combat doctrine.

One final approach to meeting the training challenge is a consolidation of resources. A current TRADOC restructuring study focuses on a "centers" and "satellites" approach to resource consolidation. This approach has already been applied to combat support and combat service support institutional structure. Unfortunately, branch

parochialism has prevented the formation of a "maneuver center" even though this would streamline doctrine and training development.[58]

There are dangers to this approach. It cannot be used as an excuse to reduce training development and writing billets, as this would only compound the problem. Instead it must be used to decrease staff overhead and reinvest these savings where they are needed to keep pace with change.

Once produced, training materials have no impact unless they are used. With distance learning comes a tremendous increase in the importance of noncommissioned officer and officer development programs at unit level. These programs have lacked structure for years and must be revitalized. Formal incorporation into the training plan addresses the single greatest resource problem with distance learning; time. Only by contracting with senior leadership for the required time can distance learning work. This becomes even more critical as service schools resort to a distance learning strategy for core level leader competencies, as a prerequisite to shorter institutional training.

Contemporary unit experiments have benefited from the focus of Army level training and doctrine development resources applied one on one to single units no higher than brigade. While these experiments cannot provide many valid lessons on how to structure the institutional army to keep pace with modernization, they can provide some valuable insights to the changing battlefield and the expanding role of infantry.

RECENT EXPERIMENTATION RESULTS

Recent simulation results culminating in the Force XXI Army Warfighting Experiment at the National Training Center confirm the potential of infantry as the

dominant force in future battle. The results of these exercises all point to trends consistent with tactics and requirements of the expanded battlefield of the future.

While digitization has been the focus of the most publicized events, other factors have impacted as well. Lethality of the dismounted infantryman has been demonstrated to be dramatically increased through improvements in weaponry and night vision equipment. For example, Dismounted Battlespace Battle Lab (DBBL) experiments including Warrior Focus and Night Eagle, used various night vision enhancements with dramatic results. In one M16 qualification firing experiment employing night vision goggles with laser aiming lights, total hits were almost the same for night as in daylight. Standing position hits were even better at night.[59] During the Warrior Focus exercise at the Joint Readiness Training Center, experimental units equipped with upgraded night vision equipment scored more hits on nighttime live fire exercises than the previous ten rotational units and suffered far fewer casualties.[60]

Recent Force XXI AWE results provide indications of a similar lethality increase against armor. The Javelin antiarmor missile, currently replacing the M-47 Dragon devastated any OPFOR that dared come within range. Unlike many of the other AWE initiatives, light infantry employment of this weapon was considered by all observers an absolute success. Innovative tactics such as ferrying light antiarmor teams around the battle field in UH-60 Blackhawk helicopters to block OPFOR movement provide a clear indication of the future capabilities of infantry married to aviation assets.[61]

This same combined infantry/aviation capability and its tremendous battlefield impact was employed in the Prairie Warrior 96 AWE at Fort Leavenworth Kansas. This

experiment provided for a "Mobile Strike Force" concept of digitized units. Two brigades of the force were standard mechanized and armored heavy units equipped with the best computerized command and control systems under development along with direct feeds of intelligence collection assets into the brigade tactical operation centers. The third brigade was a light motorized infantry unit with an armored gun system battalion and a variety of new weapons including 120mm mortar precision guided munitions and HMMWV mounted EFOGM and LOSAT.

This brigade was not resourced with the same level of intelligence and communications support provided the other heavy brigades. Task organized with the aviation brigade for additional mobility, this unit destroyed more enemy than either of the other two organizations and suffered considerably fewer casualties. Insightful tactics employed the aviation for operational and tactical mobility, the HMMWV for tactical mobility and rapid closure to targets from landing zones outside enemy low level air defense coverage, and the infantry to find and fix the enemy forces for precision attack.[62]

Similar division level experiments by the TRAC showed comparable results. Regardless of division design alternative employed, the greatest killers in the open terrain fight were consistently attack aviation, precision rocket artillery with brilliant antitank munitions and infantry. Tank engagements were minimal in their contribution (less than 10% of enemy combat vehicle kills) due to limited mobility compared to other assets.[63] Aside from employment in combat, infantry proved its utility as a security force, in the seizure of terrain required to facilitate helicopter and artillery mobility, and as an aid to disrupting and targeting enemy forces.

The DBBL is currently focused on an advanced concepts technology demonstration (ACTD) labeled the Rapid Force Projection Initiative (RFPI) using a rapid deployment variant of these tactics. The RFPI hypothesis essentially proposes that a tactical concept employing layered advanced sensor technology hunters digitally linked to precision stand-off killers such as EFOGM, HIMARS and automated howitzers firing SADARM munitions can tremendously increase rapid deployment force survivability and lethality. Experimentation is far from complete. However, initial computer simulations have shown a clear increase in effectiveness. In one scenario, an airborne brigade attacked by a threat motorized rifle regiment was defeated using conventional tactics and weapons. When the same scenario was run with the RFPI concept and equipment, the threat regiment was defeated before it ever came close to the airhead.[64]

Army After Next (AAN) wargames have taken the mobility and strategic deployability requirement to a new level. Recognizing that future combat units must be more deployable while still maintaining lethality, this experiment employed several lightweight brigade sized organizations with organic strategic self deployment capability in a multiple MRC scenario. The principle success of this approach was the demonstrated ability to rapidly execute intertheater deployment to multiple regional contingencies. Execution of the concept was only feasible by dramatically reducing the combat service support requirement for ammunition and fuel from present day requirements and through close association of ground units with their strategic lift capability.[65] When considered together with other results, AAN experimentation clearly

points to the future contribution of infantry within the context of national military strategy, operational art and tactical doctrine.

THE FUTURE CONTRIBUTION OF INFANTRY

The mission of ground forces directly addresses the need for closure to any military operation. Ground forces take the struggle to the heart of the conflict, where it directly affects the opponent's will. They create a permanent rather than a temporary presence and cannot be ignored, seizing the critical points necessary to bring a struggle to its conclusion. Air power alone is incapable of this decisive act except perhaps as a means of delivery and support to airborne troops. Neither is naval power able to execute decisive operations on its own except in a limited way and only then through the introduction of a ground force such as naval infantry into a littoral area.

If ground operations occupy the central role across the spectrum of conflict, then the infantry soldier remains the common denominator of ground operations. In combat operations the close combat soldier is the final arbiter of victory or defeat. Technological advancements are rapidly increasing the differential capabilities between the infantry soldier and his potential opponents to the point of returning infantry dominance to the battlefield. This will occur gradually with the introduction of new systems.

The first phase of change has already begun. Fielding of expanded night vision capability to every soldier is scheduled to begin this year. This fielding includes thermal sights for individual weapons that can see through smoke and fog for the first time. This one change will dramatically tilt the balance of infantry combat power in favor of the American soldier. The second major change is occurring relative to the infantryman and

his open battlefield nemesis, the tank. As the latest NTC rotation clearly showed, infantry equipped with Javelin are deadly to armored forces. These new capabilities will begin the change to a tactical doctrine that provides for a wider variety of infantry employment in a more expanded battlespace.

The second phase of change will accompany the rise of the longbow equipped helicopter as the premier tank killer of the future. Full fielding beginning in 1998 will further increase helicopter survivability, denying direct fire counter-engagement. The effect will be similar to the artillery revolution brought on by the science of ballistics combined with the field telephone. Possessing superior mobility and firepower and with the capability of terrain protection en lieu of armor, the attack helicopter will dominate open terrain battle. At this point the artillery, infantry, aviation combined arms team will begin to emerge more clearly as the heir to mobile warfare. This evolution will accelerate with further artillery and infantry developments.

By the year 2000 automated artillery and mortar fire control will be digitally linked to the individual soldier via the Land Warrior system, initiating the third phase. This coincides with the fielding of the rapidly deployable and highly mobile HIMARS rocket system capable of firing ATACMS with brilliant antitank submunitions out to a 300 kilometer range.[66] To cover this geometrically expanded battlefield with twenty-four hour all weather surveillance will require a dedicated infantry aviation team employing lightweight vehicles that can be lifted into position. By this time the requirements of an expanded battlespace will relegate units with large logistical requirements to third world armies.

The final phase of foreseeable change will coincide with the block wearout of the current family of systems beginning about 2005. By this time, the Army has planned to begin fielding of its first robotic systems,[67] and Future Infantry Vehicle development should be nearing completion, providing enhanced mobility, lethality and protection for the infantry soldier. Infantry cross spectrum dominance in a variety of environments will be improved by the introduction of the objective individual and crew served weapons in 2006. The rapidly deploying ground soldier's ability to destroy armor will have reached a new level with the introduction of LOSAT and EFOGM systems mounted on light vehicles protected by a variety of countermeasures.

Artillery systems will complete the evolution required to rapidly destroy massed armor, either stationary or moving, with the fielding of the BAT P3I brilliant antitank munition in 2005 along with fully automated artillery represented by the Crusader. These developments coincide with the fielding in 2006 of Commanche, which, when combined with lightweight infantry and artillery systems, will have transformed the combined arms team into an agile, dynamic and lethally deployable force capable of true cross spectrum dominance.[68]

CONCLUSION

Smaller forces need not be less lethal than current organizations. A carefully crafted force which incorporates new weapons capabilities and information technologies can be more deployable, more lethal and more versatile than the existing structure. This will require innovation in design and perhaps significant changes in tactics and doctrine as well. Requirements for dispersion on the open battlefield will demand increases in

mobility for all forces. At the same time, the more likely close terrain fight will demand an increase in high quality infantry offset by decreases in crew and clerical requirements allowed by automation.

Traditional roles and relationships may be dramatically altered as capabilities brought on by technological change are incorporated into the force. Regardless of change, basic principles of force design will drive us toward a balanced combined arms team structure where the capabilities and limitations of all arms, old and new, are mixed in a balanced fashion to minimize weaknesses and maximize the threat to our enemies. This union of capabilities, all strategically mobile from the continental United States and rapidly redeployable from one theater to another, meets the requirements of Joint Vision 2010 and will set the stage for transition to the Army After Next.

APPENDIX A: THE NATURE OF CHANGE

FACTORS EFFECTING CHANGE

The future is about change. Changes in military affairs are usually more psychological than they are physical with dramatic opportunities for change followed at a distance by actual exploitation. There are a variety of reasons for the slow adaptation of military organizations. Of these, perhaps senior leader attitudes are the most critical. Most senior military officers (most people in general) are prisoners of their own experience. Their ideas are most frequently tied to that experience and are not formed based on future possibilities.

Even if visionary leaders are in charge, general lack of funding after major conflicts hampers the ability of senior leaders to implement changes, even if they are obvious. Branch and service parochialism soon surface in a tough competition for limited funds with the result frequently being decisions that may be good for the service but not in the best interests of the nation. Persistent airlift and sealift shortfalls represent a dramatic example of this trend in the United States. The development of the tank in postwar Britain is another case in point.

Tied to legacy systems with little opportunity for solid research and development, military leaders are loath to adopt drastic changes for fear of the consequences of an incorrect decision to the lives of their soldiers and to the survival of their nation. Frequently this fear translates itself into a pressure for consensus and conformity, especially during periods of postwar force reductions. The result is a lethargic inability to challenge old outdated concepts or weapons which are passing from the scene.[69]

The history of warfare is replete with examples of this recurring phenomenon, as is our own military history. Cavalrymen held on to their horses for decades after their utility had passed from the battlefield, and sailors were adamant that the battleship was the backbone of the fleet long after the aircraft carrier was fielded. Clearly, emotion is a stronger force than logic.

To further complicate the situation, senior leadership is frequently challenged during peacetime by a plethora of theorists and advisors of varying quality and experience. All claim to have the "solution" to the military challenges of the future with some easy new tactical system or theory. Many are neither qualified military analysts, nor even students of military affairs. Fewer still have experience with the art of war, yet in some cases they occupy positions of power and influence. Despite the negative implication, such theorists provide at least a leavening effect for military thought and a counterbalance to conformance/consensus pressures.

Despite these challenges, productive change does occur. Generally this change comes from external forces. National survival generally opens doors to change not previously considered, and it is no wonder that defeated nations frequently ask themselves the toughest questions and prepare themselves the best for the next war while the victors remain complacent. Stalemate on the battlefield such as in World War I can generate change as well. The British were motivated to produce the tank and the Germans the infiltration tactics for this reason. Generational change as new leaders emerge and older ones retire is usually a peace time phenomenon requiring years to occur. Regardless of the reason or motivation, there will always be a constant tension

between the status quo and change. The price of neglecting change is most often paid by the infantry soldier. In order to understand when changes are required, it is critical to recognize the key trends of military history.

THE CYCLE OF ADAPTATION

The patterns of weapons development and tactical, operational and strategic thought progression operate as two interrelated cycles. Weapons development generally begins with a concept which is further developed and then fielded or proliferated throughout a military organization. This initial concept may be generated by a requirement or it may result from the exploitation of a civilian invention or discovery (historically the more frequent case).[70]

At some point in the cycle, countermeasure development begins, forcing either obsolescence or adaptation of the weapon system. Technological trends of the past century clearly indicate that the speed of the measure/countermeasure development cycle is accelerating. Equally important are trends toward miniaturization, the employment of artificial intelligence and the quantum leap in military capability associated with every breakthrough in power generation.

As an example, radio as a command and control device was first employed on ship due to size and power requirements and was only employed in an embryonic state during the First World War. The combination of the radio with better power generation capability and the mobile tank had a tremendous impact on operations during the Second World War. Additionally, the transition from human muscle power to animal power to

steam, internal combustion and then nuclear power all mark vast increases in military capability beyond other technological developments.

Tactical innovation begins with a concept which is refined into doctrine. This doctrine is then promulgated throughout the force and employed in the field. Tactical innovation, as a rule has lagged behind weapons development for several reasons. New weapons require experimentation to determine their best manner of employment. Once this is determined and codified in doctrine, it must be indoctrinated into the force. This requires time even in war; hence the commander finds himself in wartime with an extraordinary challenge.

For the future infantry force, the synchronization of technological developments and doctrinal adaptation must be improved. We can no longer afford to wait for a conflict to generate change. It will be too late at that point, and we will risk disaster. Instead, the institutional side of the Army must be reinvigorated to progressively adapt the field Army as change accelerates. Balance between both parts of the force must be achieved. One cannot remain strong at the expense of the other.

APPENDIX B: COMBAT POWER IN FUTURE BATTLE

Adaptation of weapons and military innovations into a valid tactical concept is facilitated by a clear understanding of how combat power is generated and sustained across the spectrum of conflict. The elements of military (combat and noncombat) power reflect the interaction of mobility, sustainment, lethality, information and dispersion. Four are capabilities and the fifth is an effect. This is very similar to the current Army concepts of maneuver, firepower, protection, and leadership, yet it is a more applicable model of combat power inclusive of the tactical, operational and strategic levels of conflict.

MOBILITY AND SUSTAINMENT

Mobility has increased during the 20th Century at an exponential rate. Mobility itself is a function of many factors including speed, range, and obstacle crossing capability. Factors such as combat service support requirements and leader mindset impact mobility as well. Generally, roadbound equipment limits mobility on a nonlinear battlefield. Mobility is usually inversely proportional to logistical/sustainment requirements such as fuel and weight which inhibits obstacle crossing. Lighter more agile units with fewer logistical needs generally have a larger scope of action. This agility can be created through decreased consumption, improved efficiency or by development of new power sources and through the intelligent application of resources to better focus logistics.

Mobility provides us with freedom of action and the capability to maneuver. When combined with an appropriate communications (information) system, it allows the

dispersion required to minimize the effects of enemy weapons, and it maximizes friendly lethality by placing weapons within range of the enemy at the time and place of our choosing.

LETHALITY

The historical trend toward increased firepower based lethality has continued as well. Better target acquisition (sensing), longer ranges, enhanced effects and greater accuracy (precision) have increased the lethality of fires at all levels. Yet, overall lethality, the percentage of an army actually wounded or killed in battle, has decreased due to a variety of factors, including dispersion.[71] This same dispersion has increased demand for precision weapons as mass effects weaponry has declined in utility on a fluid battlefield. Additionally, lethal effects have been driven by firepower improvements as an energy source for the last 400 years. Other developments such as directed energy could form the basis of future effects while the impact of nonlethal systems has the potential to radically alter conflict.

DISPERSION

In general terms, increased weapons effectiveness has driven a trend toward increased dispersion to offset effects. Dispersion is the ultimate expression of protection as it minimizes the enemy's weapons effectiveness regardless of type from machine gun through weapons of mass destruction.[72] The greater the capability to disperse and remain effective, the less the requirement for other forms of protection such as armor. Increased dispersion has brought its own set of requirements. If dispersion is necessary for survival, then agility becomes a requirement to retain any hope of combat effectiveness

toward the enemy. Combat service support systems must adequately sustain the dispersed force. The larger the supply requirements, the more linear, static and inflexible the operational system. Dispersion drives fluid nonlinear operations.

INFORMATION

Information requirements increase dramatically with dispersion and becomes the linchpin of maneuver. Generally speaking, the wider the view, the better the comprehension of requirements and the more efficient the response. Unoccupied areas must be observed. Static sensors lose their flexibility as the battlefield expands exponentially. Dispersed forces must be accurately identified to prevent fratricide, and units must possess a battle command capability that can merge firepower, mobility and focused logistics to generate decisive combat power and minimize wasted effort. Parallel information system developments throughout history have enabled this trend toward a dispersed battlefield. Where information systems were inadequate or unreliable, appropriate doctrines such as mission orders and the commanders intent were developed to fill the gap. The result of these interrelated developments and imperatives of mobility, sustainment, lethality, dispersion and information systems is an increasingly nonlinear battlefield with fewer yet more lethal and mobile forces in an expanding battlespace.

THE MANEUVER CONCEPT

The essence of maneuver is the mastery of time. By slowing the enemy's optempo or increasing our own we gain the ability to act faster than our adversary. Hence the ability to maneuver is only truly important with respect to the enemy and how it gives us a positional advantage by allowing us to observe (information), move (mobility) or

deliver fires (lethality). Traditional maneuver concepts address various tasks required to accomplish successful maneuver. The enemy must be found, then fixed to prevent his movement to allow time for combat power (predominately firepower) to be massed to accomplish his destruction. Hence, maneuver in itself is a microcosm of information, mobility and lethality. While not a straightforward mathematical formula, the force whose sum of capability across all three aspects is greatest usually represents the greater combat power.

No one aspect of maneuver capability is so ascendant that it is all powerful on its own. A rifleman may see a moving target and have perfect situational awareness and still not be able to hit the target. Further, each aspect of capability serves as a hedge against shortfalls in the other areas. For example, exceptional mobility may allow for recovery from an information failure, while at the same time information dominance can allow a force inferior in mobility to act decisively. Traditionally, firepower has been used to overcome shortcomings in the other two areas. For this reason the requirement to fix an enemy force was essential to success. Without fixing, massed fires from multiple sources could not be brought to bear.

A subtle transformation is underway based upon changes in information, mobility and lethal capabilities. As information becomes more precise and near real time and response times for fires steadily decrease with corresponding increases in accuracy, the requirement to fix is diminished. At times it is even better not to fix an enemy force as his actual movement increases his vulnerability by denying him valuable defensive capabilities. For example, a heavy mechanized force generally has exceptional difficulty

maintaining an adequate air defense umbrella while moving and is therefore more susceptible to air attack.

CONCEPT OF DIFFERENTIALS

Combat power is only relevant in relation to the enemy. A disparity in any area can tilt the balance of combat power decisively. For example, exceptional mobility can more than offset a numerical disparity, and mobility and information differentials can deny the enemy surprise and give it to us. However, dominance in any particular area may not translate into success especially if a force is extremely weak in another area. For example, firepower without the mobility to place it at the point of decision is useless. Equally, information superiority is futile without the means to exploit it. Knowing something and being able to do anything about it are two entirely different things. Balance is required within a force to achieve flexibility. Combinations of differentials within an organization provide this flexibility and are the basis for the combined arms team concept. Differentials in the triad of mobility, information and lethality are combined to present the enemy with an array of complex threats.

The concept of differential capabilities has resulted in a constant evolution of the combined arms team based upon technological advances and is at the heart of asymmetrical warfare. Most successful strategies, operational maneuvers and tactics are based upon an asymmetrical or indirect approach in an attack avoiding strength. Current and past technological approaches to weapon systems have been asymmetric as well, seeking to avoid strength and to attack vulnerabilities. Combinations of various differential capabilities act as protection against the vulnerability created by reliance on

any one technology or dominant capability. The implications for future force development are obvious.

APPENDIX C: FUTURE TECHNICAL DEVELOPMENTS

Technological innovations in a wide variety of weapons systems, communications, sensors and other information technologies and mobility combinations with other arms are revolutionizing the future battlefield. The results of computer assisted and simulated on the ground battle all point to trends consistent with tactics and requirements for the expanded battlefield of the future.

COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE

Information technology offers the single greatest contribution to future battle at all echelons. This revolution is a direct result of dramatic increases in computing power and miniaturization of components. Essentially, the soldier and his commanders have an enhanced sensory capability to achieve both blue, and to a limited extent red situational awareness. Combination with space based systems, has created a level of precision never experienced in war. At the same time, many reporting tasks performed by large staff sections in the past have been automated through digitization allowing staffs to be smaller and realizing personnel savings to be dedicated to other critical tasks. Information dominance efforts extend down to the soldier to include digitization of the individual infantryman. The result is the technological equivalent of Sun Tsu's admonition to know oneself and know the enemy and never fear the outcome of battle

Communications

Digital tactical communications offer a tremendous tactical advantage. The future Army Battle Command System will offer automated reporting of standard operational intelligence and logistical reports. Decision support and planning tools will be

incorporated as well. When linked with digitized terrain, enroute wargaming and rehearsal becomes a reality for the first time. Rehearsals on the same three dimensional virtual terrain as actual combat operations represents the ultimate "sand table."

Linkage with the Advanced Field Artillery Tactical Data System (AFATDS) currently being fielded will provide automated fire support command and control, which connects all fire support assets including the ability to automatically receive the Air Tasking Order from the Air Force Contingency Theater Automated Planning System (CTAPS). Digitally interfaced with a variety of sensors, AFATDS can coordinate target acquisition and direct battle damage assessment resulting in dynamic retargeting.[73]

Sensors

Sensor and target acquisition technology is rapidly advancing as well. The requirement for sensors to serve shooters at all levels is driving a layered approach from tactical to strategic levels, all with the capability to provide information to the lowest echelon. Real time sensor to shooter communications including feedback is approaching reality.

Sensor technology is far from perfect, however. Urban terrain and foliage penetration still represent significant problems. The Tactical Technology Office of ARPA began a significant effort in 1992 to develop sensor technology designed to penetrate foliage and acquire targets. Using HF/UHF ultra-wide band synthetic aperture radar techniques they successfully developed a day, night, and adverse weather surveillance capability to detect targets down to half meter size.[74]

Employing this same technology, they were able to conduct aerial digital terrain mapping with a three meter height accuracy at a 100 square kilometer per minute collection rate. This development is being applied to the Rapid Battlefield Visualization Advanced Concept Technology Demonstration employing the Army's XVIIIth Airborne Corps. The ultimate goal is "pictomap" quality of a 300x300 kilometer area available for rapid dissemination over global broadcast within twelve days of mission completion.[75]

Sensors are revolutionizing countermine operations. UAV mounted airborne standoff minefield detection systems as well as on board systems for vehicles can provide near real time detection and survey. A UAV with an imaging sensor designed to detect mines will undergo user testing this summer and in the fall the services will test eleven prototypes of land mine detection and neutralization equipment.[76]

Unmanned Vehicles

Sensors require platforms for employment. Three UAVs are currently under development to meet this requirement. Global Hawk is a self deployable high altitude UAV with a 3000 nautical mile range and 24 hour loiter capability at over 60,000 feet. It carries electro-optical, infrared, and synthetic aperture radar sensors and can transmit data via satellite or line of sight data links. Dark Star is another high altitude UAV with a 500 nautical mile range and eight hour loiter time at 45,000 feet. It requires four C-130 sorties for deployment.[77] The Outrider tactical UAV supports division and brigade level operations and is scheduled for delivery in May. With 4.9 hours endurance at 200 kilometers range, this system with four UAVs can be airlifted in a single C-130.[78]

Battalion level robotic platform efforts are currently focused on the Tactical Unmanned Vehicle (TUV). The Mobile Base Unit (robot) can operate out to 10 kilometers for 24 hours carrying a wide variety of payloads including sensors and target detection devices, lethal or nonlethal weapons or communications relay equipment. Scheduled for fielding in 2004 with six per infantry battalion, the TUV will be especially useful in penetrating hazardous locations such as urban terrain, minefields or contaminated areas. Capable of operator controlled or autonomous operations, it brings a completely new capability to the battlefield.[79]

ARTILLERY

Responsive all weather artillery will remain the primary means of fire support to land warfare for the foreseeable future. Capable of dominating thousands of square kilometers of terrain simply by traversing the weapon system, advanced artillery tube and rocket systems combined with sophisticated fire control and sensor to shooter linkage will continue to make the open battlefield increasingly more dangerous.

Tube Artillery

Even today, the fielding of improved tube artillery foreshadows future developments. The new M109A6 Paladin 155mm self propelled system represents a 30% increase in range and a 100% increase in responsiveness over previous self propelled artillery with reduction of crew size to four. The successor to Paladin, Crusader, will feature an additional 30% increase in range with a further reduction in crew size to three through automated fuel and ammunition loading systems.[80]

Towed artillery is becoming increasingly sophisticated as well. Based on the "Legal Mix" studies which led to the development of heavy force artillery, Legal Mix VIII is a DCSOPS directed study to develop artillery structure and weapons for light forces. The study is currently focused on alternatives for the direct support and general support organizations in light units. Alternatives include the M119 with a Gun Laying and Positioning System (GLPS), an ultra-lightweight 155mm howitzer under 7000 pounds, and the 120mm mortar. Each offers rapid mobility by UH-60 helicopter for crew and weapon so that essentially a battery could be carried in one lift by an assault helicopter company. GPS and self laying capabilities provide more responsive fires as well, tightening the feedback loop, increasing first round accuracy and decreasing ammunition consumption.[81]

General support candidates include the Advanced Towed Cannon System (ATCAS) and the High Mobility Artillery Rocket System (HIMARS). ATCAS, with a 30km range unassisted and a rocket assisted range of 40 km, represents a 30% range increase over the current M198 155mm towed howitzer. Using computerized gun laying electronics on individual pieces, weapons can fire from dispersed locations, respond to individual fire missions and be ready for action in two to three minutes. Like the M198, ATCAS can be rapidly lifted into position by CH-47 helicopters. Programmed to weigh in at 9000 pounds, ATCAS would, like the ultra-lightweight 155, offer the commander the option of UH-60L transported 155mm artillery. This combination is certain to enhance fire support flexibility in light units.[82]

Rocket and Munition Developments

The debut of HIMARS by 2005 will usher in a new era for rapid deployment artillery. Capable (demonstrated) of firing the entire range of the MLRS family of munitions to include the Army Tactical Missile System (ATACMS), the system is capable of destroying personnel and equipment at 300 kilometers range. HIMARS weighs 30,200 pounds with a loaded rocket pod and is C-130 transportable requiring 70% fewer airlift sorties to transport a battery than the current MLRS. Without rocket pod, the entire system weighs 24,662 pounds, 2000 pounds over the maximum lift capability of the current CH-47D under ideal conditions. However, the system was configured for compatibility with the next improved Army cargo helicopter. Rocket pods, weighing 5000 pounds are easily liftable by UH-60L aircraft. Featuring a crew of three, the system can actually be loaded and fired by a single soldier.[83]

Modernization of the current MLRS will continue into the foreseeable future. More importantly, the advancements in fire control systems and munitions for MLRS with applications across the artillery arm will have an increasing impact on open terrain battle. The basic MLRS rocket has been product improved extending the range from 31.8 to 45.5 kilometers. There is a follow on guided MLRS (G-MLRS) system with a range of 60 kilometers. This system provides a precision strike capability to MLRS.

ATACMS is most likely of all artillery rockets to impact future battle. The missile program currently contains four "blocks" with various capabilities. Block I and IA are anti-personnel/ant-materiel (APAM) warheads. Block I has a 124 kilometer range. Block IA, with a self correcting GPS guidance system, has roughly double that range

(250+ km). While the Block I programs focused APAM warheads, the Block II programs offer a powerful antiarmor capability unseen in modern war. Block II deploys thirteen brilliant anti-armor submunitions (BAT), which employ dual acoustic/infrared sensor technology. These missiles can sense and destroy through top attack moving armor targets at a range in excess of 140 kilometers. Block IIA will carry six BAT P3I submunitions, which employ an additional millimeter wave radar sensor to detect and destroy cold stationary targets at twice the range of Block II rockets.[84]

Technological improvements in rocket munitions have crossed over into tube fired projectiles. Loral Vought Systems has examined the BAT munition for use in a rocket assisted projectile. Plans call for a single rocket to carry one BAT to a 64 kilometer range. This will expand the current Sense and Destroy Armor (SADARM) round capability, which began initial low rate production in 1996. The SADARM 155mm round fires two top attack submunitions which employ dual-mode infrared and millimeter wave radar to find armored targets out to a range of 22.5 kilometers.[85]

Additional research into projectile flight control promises to quadruple 155mm projectile accuracy out to maximum range. On board ballistic computers interfaced with GPS along with "guided competent munitions" based on gun hardened GPS/INS technology provide tremendous range, accuracy and responsiveness increases with fewer personnel, smaller units and reduced logistical requirements.[86] Given future capabilities to compute a ballistic solution with increasing speed and accuracy combined with turret stabilization technology, dispersed fire on the move artillery is within the realm of the possible.

AVIATION

The advent of helicopter operations in the 1950s initiated a change in the way future wars would be fought across the spectrum of conflict. For the first time since the mechanization of armies, the mobility differential of cavalry returned to the battlefield. The uniqueness of the helicopter's ability to cross terrain obstacles further enhanced its capability to operate in all terrain environments and levels of conflict. The validity of this statement has been repeatedly proven from Vietnam to Desert Storm. Helicopters employed with maneuver ground forces, to deliver fires and as a maneuver force themselves have dramatically changed modern tactics.

The struggle of the helicopter for acceptance rivals that of the tank. Initially stymied by the Key West accords which limited Army procurement and prohibited armed aircraft, development proceeded in secret. Pioneers of the attack helicopter such as LTC Jay Vanderpool, an artillery officer, developed rocket firing helicopters for maneuver and support of ground troops, as an Air Force preoccupied with strategic bombing and nuclear conflict neglected their service requirements to support the more probable asymmetrical conflicts which eventually arose.[87]

With the development of turbine engines to replace piston driven aircraft, the helicopter came into its own with the UH-1 and the Vietnam War. At the successful conclusion of the air assault tests, the 2d Infantry Division at Fort Benning was reflagged as the 1st Cavalry Division and deployed directly to Vietnam where it validated the concept in combat. This validation continues today along with the research and development that has the potential to revolutionize the maneuver picture for the 21st

Century. Helicopter technology has come a long way from Huey "slicks" and gunships. Today's UH-60L Blackhawk lifts over twice as much weight as the UH-1H. The greatest improvements, however, have come in the development of attack helicopters.

Replacing the venerable AH-1 Cobra, the AH-64 Apache combined with laser guided Hellfire missiles changed forever the domination of armor in the open terrain battle. Capable of hitting targets eight kilometers away, the Apache was virtually invulnerable to return fire from armored units. With the fielding of Apache Longbow systems a new dimension has been added. Using a millimeter wave radar air/ground targeting system, Longbow allows ripple fire launches of fire and forget missiles. The system can manage hundreds of targets and pass firing information to multiple firing platforms. The Longbow Apache unmasks for a few seconds to fire and then quickly returns to defilade making it virtually invulnerable to attack, while delivering a massive blow.[88]

Longbow technology has been adapted to the OH-58 in the form of the OH-58D Kiowa Warrior. In an attempt to deliver rapidly deployable antiarmor support to light forces, the Kiowa Warrior is equipped with the same airborne target handover system and is capable of digital transmission of target data to other attack helicopters or to TACFIRE and digitized ground maneuver forces. The greatest advantage of the Kiowa Warrior is the rapid deployability by strategic and tactical airlift of large numbers of aircraft directly to a crisis location.[89] The aircraft does have load, range and speed limitations, however. These limitations along with survivability concerns over air defense improvements have led to the development of the RAH-66 Commanche.

Scheduled for fielding in 2006, the Commanche represents a leap ahead attack and reconnaissance helicopter capability. Employing F-22 Advanced Tactical Fighter technologies and digitally integrated with joint sensors and weapons platforms including the Joint Surveillance and Target Attack Radar System (JSTARS), the RAH-66 is faster, stealthier and has a wider radius of action (out to 381 kilometers) than previous systems. The Commanche is also rapidly deployable. A single RAH-66 can deploy by C-130 with the capability for 14 stowed antiarmor "kills" and be operational within 22 minutes at the other end. A C-17 can deploy four aircraft and a C-5 carries eight.[90] Compare this to the single M1A1 tank transportable by the C-17, and a clear picture of useable combat power for force projection becomes evident.

The ability for wide ranging yet precise battlefield operations is incomplete without viable communications coverage. Aviation Satellite Communications (AVSATCOM) are being developed by the U. S. Army Communications-Electronics Command for this purpose. This area has long been a problem for aviation operations employing nap of the earth flight profiles at extended ranges. AVSATCOM is intended to employ low probability of intercept and detection communication and GPS technologies to provide constant two way communications and automatic system tracking for air assault and deep attack operations. This capability will provide the same situational awareness for aviation forces as demonstrated for ground forces by the Force XXI AWE.[91]

There are a number of weapons developments that will contribute to the lethality and information gathering capability of aviation forces in the future. Two in particular,

directed energy and the precision strike Ferret missile have significant potential. There have been no proposals to date for mounting directed energy weapons on helicopters either in a target acquisition or attack role. However, the combination of directed energy with an airborne platform presents tremendous potential.

The Ferret represents a more conventional approach to increased target acquisition and destruction. Ferret is an aviation launched missile that has the capability to find, identify and engage critical high value targets such as air defense systems, ballistic missile launchers, armored vehicles and other helicopters. Essentially combining the role of UAV and missile, this system flies well beyond Hellfire range and is extremely useful for penetrating enemy air defenses.[92]

ARMOR

The field of armored combat is experiencing changes as well. Advances in tank weapons and ammunition, fire control, armor, and protection mechanisms assure the tank a continued role on the 21st Century battlefield.

Weapons and Ammunition

The U.S. Army is currently experimenting with weapons and ammunition designed to increase the range, accuracy and lethality of the tank. The advanced Tank Armament System (ATAS) will reduce target engagement times through automatic multiple target cueing and tracking similar to the Israeli Merkeva tank. Future tanks will have digitized fire control with the capability for automatic bore sighting and zeroing. Introduction of a longer barrel will extend the range of the 120mm smoothbore gun by one kilometer. Many modern tanks including the French LeClerc and the Russian T-72

and T-80 tanks employ auto loaders to speed engagement times as well. The ATAS features the Army's first autoloader system with a rapid fire rate of 12 rounds per minute (one round every five seconds).[93]

New ammunition capabilities allow longer range attacks on a variety of targets as well. The Smart Target Activated Fire and Forget (STAFF) round is designed for top attack of defiladed targets. The Tank Extended Range Munition (TERM-KE) is a soft launch rocket boosted kinetic energy munition that will further extend tank lethality and has potential for fire and forget adaptation. Various other technologies such as fusing allow for selective engagement of either air or ground targets by the same tank round.[94]

Armored Protection

The very nature of armored vehicles will change with time. The current M1A2 has reached the end of its feasible weight limits. At over 68 tons, it can only be effectively employed under open terrain conditions and is not capable of cross country maneuver either due to bridge classification or ground pressure considerations in an increasing number of scenarios. Revolutions in composite materials and vehicle self defense systems will likely reverse the historic trend to heavier and heavier armor which eventually relegated the feudal knight to the museum.

Current research is attempting to overcome the mobility and sustainment problems caused by increased weight while retaining armored protection through the employment of composite materials. Composite hulls for armored vehicles usually employ a molding process where a resin or plastic is combined in a single unitary construction with a strong fiber material. Such composite hulls offer a 33% weight

savings over conventional metal armor and do not require spall liners for crew protection. Potentially lighter, faster and cheaper to produce (requires no welding), they are more deployable and sustainable and more replaceable in time of war; all difficult challenges for our current series of tank. When combined with design modifications employing turretless systems, survivability is further enhanced by both profile and weight reduction or the transfer of armor to the hull. The result is increased agility and crew protection and decreased signature.[95]

Vehicle Defense Mechanisms

Protection mechanisms for vehicle defense provide a second means of increasing survivability while reducing weight and increasing mobility. A wide variety of laser and radar warning systems are employed on combat systems today. Fixed and rotary wing aviation have employed them for years. With the proliferation of laser and radio frequency guided antiarmor munitions, these devices have begun to appear on armored vehicles as well. The real challenge is to defeat these munitions before they can destroy the vehicle, however. Two types of system are under various stages of development. One, the Rx-IMAGE jams the imaging system of the incoming munition. Designed to defeat smart top attack munitions, it is effective against both infrared and radio frequency based sensors and may be employed for point defense of a single vehicle or for area defense of a group.[96]

The other system employs a Phalanx type concept to defeat missiles and HEAT rounds. Essentially a radar directed shotgun, this system destroys the incoming projectile at a range from two to twenty meters. Such systems are being offered by Russia for

export today. While adequate for medium weight armored vehicles, current systems of this type do not address a SADARM type threat and cannot protect light vehicles. To meet this requirement, the Tactical Technology Office of ARPA is developing a guided munition package designed to provide the same level of protection to light vehicles as that which is currently offered by tank armor. With a planned standoff range of 100 meters, the Small Low Cost Interceptor will undergo live testing in 1998. This same technology can be employed for the protection of high value assets such as air defense systems or helicopters as well.[97] A combination of Phalanx and jamming systems offers a tremendous potential to increase armored survivability while reducing weight.

Expeditionary Systems

If technology is pointing the way to greater survivability and lethality with decreasing weight, it is also pointing out the mismatch in usable force structure based on constant upgrades of the current M1 series tank. The missing ingredient for the 21st Century heavy force is a family of expeditionary tanks and support vehicles. The technology exists today to develop and field a fully autoloading, high rate of fire and highly survivable and lethal tank that could overmatch M1 capabilities in a wide variety of terrain conditions. A crew size of three (conceivably smaller) would allow for a smaller manpower requirement while increasing strategic, operational and tactical agility and combat power. Reduced weight and sustainment requirements translate into a larger radius of action required on an increasingly dispersed battlefield. Better yet, it could actually deploy rapidly by air to any threatening crisis area. A tank in the 17-23 ton range can be transported by the C-130H. The generally accepted vehicle weight requirement for adding a 120mm gun is 25 tons, within the lift capability of the new C-130J model.[98]

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