

Javelin; the Potential Beginning of a New Era in Land Warfare

**A Monograph
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14. ABSTRACT

The US Army has completed fielding of the Javelin Antitank Weapon System to Infantry Battalions in the 75th Ranger Regiment and the 82nd Airborne Division. In the year 2000, the fielding team is issuing the Javelin to the Second Infantry Division in Korea. Thus far, results from the soldiers and leaders indicate that the fire and forget Javelin is largely accepted as a dramatic improvement over its wire-guided predecessor the Dragon. During numerous fielding tests, live fire tests, and force on force tests at the National Training Center, technological and tactical experts have closely monitored the performance of the Javelin. The capabilities and potential impact of this new weapon system obligates the U.S. Army to examine how it intends to integrate the Javelin system into all warfighting domains. This monograph answers the question whether the introduction of the Javelin into the U.S. Army's Light Infantry Battalions marks the beginning of a revolution in ground antiarmor warfare. This monograph begins with a comparison of the Javelin to the Dragon to demonstrate the significant increase in capabilities. The monograph establishes clear criteria for distinguishing a military revolution from an evolution and establishes the Javelin's link to the U.S. military's present Revolution in Military Affairs (RMA). The Infantry Revolution of the 1300s is examined as an example of a military revolution and antitank guided missile (ATGM) use during the Arab-Israeli War of 1973 is examined as an example of a military evolution. The monograph studies U.S. Army and U.S. Marine Corps relevant doctrinal manuals and text to determine if the introduction of the Javelin has caused any changes in the antiarmor tactics. The review will assess the progress and quality of incorporating Javelin tactics into doctrinal publications and demonstrate that much progress is still needed in developing new tactics for employing Javelin equipped units in both offensive and defensive scenarios. The most challenging tests for Javelin equipped units thus far have been two rotations to the U.S. Army's National Training Center to face a world class opposing force. In both cases, the performance of the Javelin served as proof that a light infantry force used as part of a combined arms team could achieve far greater results than were previously possible. The fire and forget technology that the Javelin uses far exceeds the capabilities of first and second generation guidance systems. The Javelin has caused other nations to cease research on now outdated guidance technologies for ATGMs and to develop or purchase ATGMs that use third generation technology. The monograph examines the ability of the Javelin to defeat threat Active Protection Systems (APS), and concludes that in most cases, the Javelin has a marked advantage against all known APSs and can sustain that advantage for at least the next ten to fifteen years. The monograph concludes that the Javelin is a weapon with revolutionary potential. However, for the full revolutionary potential of the Javelin's operational impact to occur, the U.S. Army must embrace several additional measures. The monograph categorizes the recommendations using warfighting requirements in the domains of doctrine, training, leader development, organization, materiel, and soldier (DTLOMS).

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Abstract

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The US Army has completed fielding of the Javelin Antitank Weapon System to Infantry Battalions in the 75th Ranger Regiment and the 82nd Airborne Division. In the year 2000, the fielding team is issuing the Javelin to the Second Infantry Division in Korea. Thus far, results from the soldiers and leaders indicate that the fire and forget Javelin is largely accepted as a dramatic improvement over its wire-guided predecessor the Dragon. During numerous fielding tests, live fire tests, and force on force tests at the National Training Center, technological and tactical experts have closely monitored the performance of the Javelin. The capabilities and potential impact of this new weapon system obligates the U.S. Army to examine how it intends to integrate the Javelin system into all warfighting domains.

This monograph answers the question whether the introduction of the Javelin into the U.S. Army's Light Infantry Battalions marks the beginning of a revolution in ground antiarmor warfare. This monograph begins with a comparison of the Javelin to the Dragon to demonstrate the significant increase in capabilities.

The monograph establishes clear criteria for distinguishing a military revolution from an evolution and establishes the Javelin's link to the U.S. military's present Revolution in Military Affairs (RMA). The Infantry Revolution of the 1300s is examined as an example of a military revolution and antitank guided missile (ATGM) use during the Arab-Israeli War of 1973 is examined as an example of a military evolution.

The monograph studies U.S. Army and U.S. Marine Corps relevant doctrinal manuals and text to determine if the introduction of the Javelin has caused any changes in the antiarmor tactics. The review will assess the progress and quality of incorporating Javelin tactics into doctrinal publications and demonstrate that much progress is still needed in developing new tactics for employing Javelin equipped units in both offensive and defensive scenarios.

The most challenging tests for Javelin equipped units thus far have been two rotations to the U.S. Army's National Training Center to face a world class opposing force. In both cases, the performance of the Javelin served as proof that a light infantry force used as part of a combined arms team could achieve far greater results than were previously possible.

The fire and forget technology that the Javelin uses far exceeds the capabilities of first and second generation guidance systems. The Javelin has caused other nations to cease research on now outdated guidance technologies for ATGMs and to develop or purchase ATGMs that use third generation technology. The monograph examines the ability of the Javelin to defeat threat Active Protection Systems (APS), and concludes that in most cases, the Javelin has a marked advantage against all known APSs and can sustain that advantage for at least the next ten to fifteen years.

The monograph concludes that the Javelin is a weapon with revolutionary potential. However, for the full revolutionary potential of the Javelin's operational impact to occur, the U.S. Army must embrace several additional measures. The monograph categorizes the recommendations using warfighting requirements in the domains of doctrine, training, leader development, organization, materiel, and soldier (DTLOMS).

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Catalyst for Change

In early August 1990, the 82nd Airborne Division deployed to Saudi Arabia, drew a line in the sand, and prevented the Iraqis from crossing into Saudi Arabia. One of the key weapons that the Division's infantry battalions relied upon to thwart any Iraqi attack was the Dragon antitank missile system. Throughout the Army, a sigh of relief was felt once heavier forces arrived in theater to reinforce the Division's infantry battalions' thin defense. Why did apprehension exist over the highly capable 82nd Airborne Division's ability to hold the line? Largely it was because its infantry battalions had only 20 TOW (Tube-launched, Optically tracked Wire-guided) weapon systems with which to defend their sector against an armored threat. After the TOW, the next antiarmor weapon in the infantry battalion was the M-47 Dragon. The apprehension was most acute with the Dragon. Few had confidence in the Dragon's reliability. Fortunately, the Iraqis did not test the Division's defense. This operation did make it readily apparent that light infantry battalions desperately needed more lethality against an armored enemy.¹

Eight years later, the desert was now a half world closer to home for the Second Brigade of the 82nd Airborne Division. In January and February 1999, they fought the mighty Krasnovian hordes of the 11th Armored Cavalry Regiment just a few kilometers outside Irwin Military City in the Mojave Desert during National Training Center (NTC) Rotation 99-04. This brigade of two airborne battalions and one armor battalion convincingly defeated the Opposing Force (OPFOR) through most of its force on force training days.² How did this happen? Superior, aggressive leadership played a decisive role, though quality leadership thrives in most units that train at the National Training Center. What was the technological difference between this rotation and so many others like it in the past? It was the existence of two Airborne Infantry battalions recently equipped with the Javelin antitank weapon system. This man portable fire and forget weapon made the difference in forcing the enemy regiments to change their strategy for fighting light infantry battalions. Normally the location of a light infantry battalion was a potential vulnerability for the OPFOR to exploit. With Javelin equipped airborne infantry battalions now on the ground,

the OPFOR sought out these battalions, not so that they could target them for exploitation, but so that they could avoid them.³

This monograph examines why such a significant difference in outcomes occurred. This monograph demonstrates that the Javelin is a weapon with revolutionary potential, and that the United States military must take additional steps in order to maximize its full potential. This monograph answers the question whether the introduction of the Javelin into the U.S. Army's Light Infantry Battalions marks the beginning of a revolution in ground antiarmor warfare. The monograph explores the Javelin's relationship with the United States' Revolution in Military Affairs that is now underway throughout the U.S. armed forces. The monograph then examines antiarmor doctrine and organization structure within light infantry units, antitank guided missiles and armored vehicles' linked evolution, and the Javelin's operational impact. The monograph provides recommendations for the U.S. military to implement to ensure the full realization of the Javelin's revolutionary potential.

Dragon

The Javelin's predecessor, the Dragon was first deployed in 1975. The original idea for the Dragon began in 1959 when the US Army Ordinance Missile Command suggested the development of a medium-range heavy assault weapon. In 1963, the US Army's Combat Development Command (CDC) concluded a need for a medium range antitank weapon existed and development of the Dragon was soon underway. After the long process of weapon development and testing, the first tactical deployment of the Dragon to a unit in U.S. Army Europe occurred in January 1975.⁴ By April 1981, deployment of the basic Dragon missile was complete throughout the Army. In Light, Airborne, and Air Assault Infantry Battalions, each rifle company contained six Dragon systems each, totaling 18 in each light infantry battalion throughout the Army.⁵

The most significant drawback to the Dragon weapon is the fact that a gunner has only a 20 percent chance of hitting his intended target once he fires his missile.⁶ With such a slim margin

for gunner success, unsurprisingly, U.S. doctrine devotes scarce attention to employing the system. The low probabilities of hit and kill with a Dragon missile was a primary contributor for the Department of the Army's decision in October of 1979 not to improve upon the Dragon system. Instead, they decided to develop the Advanced Medium Antiarmor Weapon System (AMAWS).⁷

Javelin History

The genesis of the Javelin began as early as January 1978 when an antiarmor Mission Needs Statement identified the deficiencies of the Dragon as the Army's current manportable antiarmor weapon.⁸ In 1986, the Army released the required operational capability to industry and they examined three technology concepts during proof of principle testing. The three technology candidates were fiber optic guided missile, laser beam rider and fire and forget, with the fire and forget technology of the contract team from Texas Instruments and Martin Marietta demonstrating the most capable, though riskiest system. Initially referred to as the Advanced Antitank Weapon System-Medium (AAWS-M), the Army renamed the AAWS-M the Javelin.

The Initial Operational Test & Evaluation (IOTE) for the Javelin occurred from October to December 1993. The IOTE compared Dragon equipped infantry company performance to the performance of the same companies equipped with the Javelin in both the Army and Marine Corps. The IOTE assessed the operational effectiveness of the Javelin as compared to the Dragon in the areas of mission performance, survivability and portability. The IOTE Report stated that units equipped with the Javelin "are substantially more effective than units equipped with the Dragon."⁹ Javelin equipped units killed OPFOR armored vehicles, were more successful, had fewer casualties, could influence the battle from a greater range, and had a far superior probability of hit and kill over all ranges and conditions. No significant movement rate differences existed between the Javelin and Dragon gunners.¹⁰ The IOTE concluded that the Javelin was effective, but needed further assessment for suitability. After enhancements and corrections to the system, the U.S. Army conducted further testing in the form of a Limited User

Test (LUT) in 1996. After live fire testing and evaluation in 1997 the Army judged the Javelin Anti-Tank Weapon System to be operationally effective and full rate production commenced.¹¹ In June 1996, the first unit, 3rd Battalion, 75th Ranger Regiment at Fort Benning Georgia, received the Javelin.¹²

Javelin Characteristics

The Javelin system consists of the missile, which is contained in a disposable Launch Tube Assembly, the reusable tracker called the Command Launch Unit (CLU), and training devices. The Javelin has a dual attack mode capability. It can either attack a target such as a helicopter or bunker in a *direct fire* mode or it can use a *top attack* mode to attack armored vehicles from the top where their armor protection is the most vulnerable. The gunner selects which mode he desires based upon his target selection and assessment.

The significant difference from the Dragon is that the Javelin has a fire and forget guidance system. It is the world's first ground launched medium range fire and forget antitank guided missile.¹³ The gunner acquires the target in his line of sight through his CLU, once the target is locked onto by the tracker, he fires the missile. The gunner is then free to immediately move out of the area, increasing his survivability. He no longer has to track his target until missile detonation, as was the case with the Dragon. The Javelin also has a soft launch feature that significantly reduces the visual and acoustical signature the missile makes compared to the Dragon.¹⁴

The Command Launch Unit is an integrated day and night sight. It provides the gunner the capability of surveillance, target acquisition, missile launch, and damage assessment. The sight is a passive imaging infrared (I2R) system. The sight converts the infrared light into an image for the gunner to identify armor targets accurately out to a range of 3000+ meters under most conditions. The sight may also be used separate from the missile in a surveillance role. The sight can operate on a single disposable lithium battery (BA-5590/U) for over four hours and requires

no coolant bottles. The system has a built in test that alerts the gunner when the system is not functioning properly.¹⁵

The round consists of the disposable launch assembly, battery coolant unit (BCU), and missile. The launch tube serves as a handling and carrying container and launch platform for the missile. The I2R system of the missile locks onto the target before launch and is self-guiding. The missile uses a tandem shaped charge warhead and a two-stage solid propellant with a low signature soft launch motor and a minimum smoke flight motor.¹⁶

The training devices that complete the system are the Basic Skills Trainer (BST), Field Tactical Trainer (FTT), and Missile Simulation Round (MSR).¹⁷

The Army's Special Text 7-10-1, *Tactical Employment of the Javelin Antiarmor Section* summarizes the similarities and differences between the Javelin and the Dragon in the following table:

	JAVELIN	DRAGON
Type System	Fire and Forget	Wire-guided
Carry Weight (Total):	49.2 lb. (day & night)	73.2 lb. (day & night) 37.5 lb. (day only)
Command Launch Unit:	14.1 lb. (day & night)	36 lb. (night) 8.5 lb. (day)
Round:	35.1 lb.	28.9 lb.
Crew:	Man portable	Man portable
Ready to Fire:	30 sec or less	less than 30 sec.
Reload Time:	20 sec or less	Time of flight + 20 seconds
System Components:	Command Launch Unit Round of Ammunition	Day sight Thermal sight Round of ammunition
Method of Attack:	Top attack or Direct fire (Top attack is normal)	Direct fire only
Range:	2,500 m	1,000 m
Fighting Position restrictions*:	1m x 2m ventilation is recommended	1m x 2m ventilation is recommended
Guidance System:	Thermal seeker	Wire guided
Sights:	Integrated Day/Night sight unit	Two separate sights day and night
Time of Flight:	1,000m = approx. 4.6 sec 2,000m = approx. 14.5 sec 2,500m = approx. 19.0 sec	1,000m = 10.0 sec

Sight Magnification	4X day, 4X and 9X night	6X day, 4X night
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* The system is capable of being fired safely and with no performance degradation from a covered fighting position (two man with openings front and rear) or a 12' x 15' room with a 7' ceiling.

Table 1 Javelin and Dragon Characteristics¹⁸

In most cases in the Army, the Javelin will act as a one for one replacement for the Dragon. Currently the basis of issue for the Javelin throughout the Army is six per Infantry Company, three per Combat Engineer Company, five per Heavy Scout Platoon, and fourteen per Special Forces Group.¹⁹ Currently the Interim Brigade at Fort Lewis plans to receive 27 CLUs for each of the three Infantry Battalions (one for every infantry squad), 36 CLUs for the Reconnaissance Battalion, and four CLUs in the Engineer Company.²⁰ The Army has completed fielding the Javelin in the 75th Ranger Regiment and the 82nd Airborne Division. In the year 2000, Army forces in Korea are receiving their Javelin issue and New Equipment Training (NET).

The Marine Corps is not conducting a one for one replacement of the Dragon. The Marine Corps has changed the organization of their antitank (AT) platoon in their infantry battalions from twelve Dragons to eight Javelins and cut the carrying capacity of the AT section from 36 to 16 Javelins. The primary reason for the change in the Marine Corps was the fact that now an AT platoon equipped with Javelins could do as much damage as its former larger self due to the improved lethality of the Javelin.²¹ The Marine Corps started fielding the Javelin in 1999.

Defining Military Revolution and Evolution

What really is a military revolution? Michael Roberts first introduced the idea of a single military revolution during his inaugural lecture “The Military Revolution, 1560—1660” at Queens University Belfast in 1955.²² Today, the term military revolution is frequently associated with the in vogue term *revolution in military affairs* (RMA). Theorists and historians will argue whether or not the terms are synonymous or have different meanings. A precise definition for a military revolution and RMA can be difficult to define since it remains a term that is open to interpretation. Today’s leaders of the United States military believe the military is currently in

the midst of a revolution in military affairs. The military has sought much attention to the topic as scholars and the military as a whole strive to explore and define the specifics of the RMA now underway. The Department of Defense's Office of Net Assessment defines an RMA "as a major change in the nature of warfare brought about by the innovative application of technologies which combined with dramatic changes in military doctrine, and operational concepts, fundamentally alters the character and conduct of operations."²³

It was actually in the Soviet Union where the suggestion was made that the United States was in the midst of a military revolution of sorts. The Soviet Union's military leaders in the late 1970s first wrote about a military technical revolution. By the mid 1980s, Chief of the Soviet General Staff, Nicolai Ogarkov, became its chief advocate and strongly argued for the Soviets to increase their military budget in order to keep pace with the United States, which he believed was ahead in the military technical revolution. His advocacy for a larger Soviet military budget led to Gorbachev's eventual firing of him.²⁴ Washington did not ignore the concept of a military technical revolution. The Pentagon's Director of Net Assessment, Andrew Marshall, closely followed the Soviet's military decline. Operation Desert Storm reinforced the idea that a military technical revolution was under way. In 1992, the Secretary of Defense, Dick Cheney, concluded in the official after action report concerning the Gulf War that "the war demonstrated dramatically what has been called 'the military technical revolution.'"²⁵ By 1993, Marshall and his assistants deemed the term military technical revolution inadequate to capture the full breadth of the revolution. Their studies of earlier periods of military change suggested that while technology was an aspect of military change in capabilities, it did not sufficiently account for what seemed to qualify as a real military revolution. Most case studies they examined indicated that the significant changes in military capabilities had occurred when shifts in tactics, doctrine, and organization accompanied new weapons or other military equipment. Real military revolutions involved more than technology, they affected a wider range of military "affairs".

Thus by 1993 the term revolution in military affairs (RMA) had replaced military technical revolution for describing the revolution believed to be currently underway in the U.S. military.²⁶

James Fitzsimonds and Jan Van Tol, in their article “Revolution in Military Affairs,” sought to provide clarity in the quest for a common understanding of what a revolution in military affairs really meant. An RMA entails a fundamental change in the nature of warfare. It may be difficult to ascertain if one is currently involved in a revolution in military affairs, but it is often clear *ex post facto*. The rapidity of the change is unimportant, as it is relevant only in comparison to potential adversaries’ capabilities. The most important factor of an RMA is the magnitude of the change compared to preexisting military capabilities.²⁷ Today, technological advances are normally a prerequisite for a revolution in military affairs, but technology alone only provides the potential for an RMA. By itself, it may provide an advantage on the next battlefield but will not make a significant impact if not paired with other accompanying changes in the military. Fitzsimonds and Van Tol suggest three common prerequisites that must exist in order to achieve full realization of an RMA:

- Technological development—New technologies are developed into practical military systems that provide a marked advantage over potential adversaries.
- Doctrinal or Operational Innovation—To fully exploit the capabilities of new systems, operational concepts incorporating and integrating the next technology must be developed into coherent doctrine that becomes accepted and practiced.
- Organization Adaptation—Often the most difficult aspect of the RMA is the overcoming of bureaucratic resistance and gaining acceptance to institutional changes. Organization structures must change to maximize the potential of the new technology and accompanying doctrine.²⁸

The ideas of Fitzsimonds and Van Tol suggest the existence of a trinity between technology, doctrine, and organization in order to achieve full realization of a revolution in military affairs. However, social, political or economic factors may also serve as a catalyst for a RMA. An

example of such is the French Revolution and the adoption of the levee en masse method of fielding an army. The levee en masse altered the scale of land warfare. Here, we have a military revolution resulting from social and political upheaval, not from a prerequisite of a new technology. Additionally, a specific unrealized military need may be the impetus for conception of a military revolution, such as the amphibious warfare revolution that began once a need for such a capability was identified. Fitzsimonds and Van Tol's explanation appears only valid for post Industrial Age nations. A more complete understanding of military revolutions and RMAs is necessary.

Historian Clifford J. Rogers, in his *The Military Revolutions of Hundred Years War*, claims that a series of military revolutions have occurred from the middle ages to today and that the frequency of revolutions increases as one approaches this century. During the Hundred Years War and the succeeding centuries such revolutions included the "Infantry Revolution", the "Artillery Revolution", the "Artillery Fortress Revolution", and the revolution in administration.²⁹

As evidenced above, and sought by the US military, many opinions exist concerning military revolutions. In light of current opinions on revolutions in military affairs, one can acknowledge that revolutions may have an impact of varying magnitude and at different levels. Revolutions in Military Affairs is a much broader term than military revolution and it implies integrated technological, doctrinal, and organization changes to the military that change the nature of warfare. The impact of an RMA is not only felt within nations' militaries but on social, political, and economic levels as well. Within an RMA, or possibly independent from a greater RMA, numerous military revolutions occur that involve doctrinal, technological, and organizational changes that though, individually may not have the same impact as all of the different revolutions combined, still warrant individual attention to ensure full benefit can be gained from the revolution. Together, the synergy of these revolutions forms the greater encompassing RMA.

Based upon the previous explanation and historical precedents, objective criteria for assessing whether or not a military revolution in land warfare, spurred by a technical advancement or innovation, exists or has the potential to occur would be:

- 1) The new military technology necessitates changing doctrine and tactics to capitalize on the full potential of the new system.
- 2) The new military technology is a catalyst for organizational restructuring and personnel changes to maximize the benefits of the new system and minimize or remove other systems that no longer warrant as much emphasis.
- 3) If known to allies and potential adversaries, the new military technology requires our potential adversaries to develop new tactics and/or new technological solutions to counter the advantage the systems gives to the owner.
- 4) Most importantly, a revolution signifies a significant shift away from a former method of conducting some nature of warfare. The results of the revolutionary change are felt not only at a tactical level of war but at the operational and strategic level as well. It is a leap ahead in capability as opposed to just an evolved improvement that gives the possessor a distinct advantage in combat over any potential adversary who is now forced to develop new solutions or counter-measures.

A revolution does not occur instantly. For the full impact of a military revolution to occur, linked doctrinal, organizational, and technological changes must happen. Without these necessary accompanying changes, a military could have a revolutionary new piece of equipment without any revolution ever occurring.

Any potential military change that does not include linked advancements in technology, new coherent doctrine and organizational restructuring is not a revolution, but an evolution. An evolution reflects a gradual process in which changes occur. For neither revolutions nor evolutions do the changes occur overnight but over a period. The difference between an evolution and revolution in the military may come down to a measurement of the significance of

the impact (if any, in the case many evolutions) the change or changes has upon the nature of warfare.

The Infantry Revolution of the Hundred Years War

An example of a previous military revolution that meets the criteria is the Infantry Revolution that occurred from roughly 1302 to 1346. This revolution marked the resurgence of the infantry to a dominant role on the battlefield over the 14th century version of the modern tank, the heavy cavalry.³⁰ Before this time, from roughly 1066 to the beginning of this revolution in the early 1300s, infantry were generally used in a defensive role. Using tight formations of pole arms and crossbowmen, they would protect the cavalry while it formed for a charge. The mounted knight and his horse were the decisive arm of combat. The infantry's role was mainly to protect, acting as his shield until he struck.

With the introduction of the six-foot yew English longbow and the Swiss pike, the common infantryman could now penetrate and kill the heavy cavalryman. With these new weapons, doctrinal changes followed to maximize their potential. The English began to employ "pike and shot" combinations on the battlefield and no longer relied on the heavy cavalry to dominate the battlefield. They integrated lance-like pikes into formations with archers. Because the English archers had superiority in range, rate of fire, and penetration over their opponent's bows, the enemy's cavalry and archers could not break their pike and shot formations and suffered dramatically one-sided losses.³¹

The impact of the new technological and doctrinal improvements were most dramatically evidenced when the English, lead by Edward III, fought the French at the Battle of Crécy on August 26, 1346. The English army consisted of 3,900 knights and men-at-arms (heavy cavalry), 11,000 archers and 5,000 Welsh light troops. The English had the advantage of reaching the field of battle first and formed for battle. The bulk of English cavalry fought dismounted alongside archers and other common infantrymen. The archers were arranged on the outer flanks of each

division and echeloned forward to provide clear, converging fields of fire. Each division retained a small mounted heavy cavalry reserve to counter any French heavy cavalry penetration.³²

The French outnumbered the English roughly three to one, consisting of 12,000 heavy cavalry, 6,000 Genoese mercenary crossbowmen, 17,000 additional light cavalry, and some 25,000 undisciplined militiamen. The French army, led by King Philip IV, stumbled into the English army at approximately six o'clock that evening. He was able to get his disciplined and well-trained Genoese crossbowmen to the front and they moved down the hill toward the English lines to attack. They stopped approximately 150 yards short of the English front lines and let fly their first volleys of arrows, but their arrows mostly fell short. The English longbowmen responded with their own volley that fell with murderous accuracy on the front ranks of the Genoese crossbowmen.³³

The crossbowmen were routed and reeled back up the hill toward the French heavy cavalry. The overconfident French heavy cavalry charged down the hill trampling many of their infantrymen. The English archers then let fly their volleys at the attacking heavy cavalry creating a mangled horde of knights and crossbowmen. The French seemed unwilling to accept the reality that the English archers were cutting down their knights and continued to send sixteen successive reckless charges into the English lines. The French cavalry that did close on the English formations met a capable concentration of English spears to turn back the oncoming attacks.³⁴

By midnight, the French had given up and the battle had ended. The French suffered an alarmingly higher number of casualties, more than an army was accustomed to during this period. They had lost 1,542 lords and knights, about 15,000 men-at-arms, crossbowmen, and infantrymen, and thousands of horses. The English had only lost about 200 men, dead and wounded, including two knights, 40 men-at-arms and archers, and "a few dozen Welsh."³⁵ This battle marked the beginning of the end for the heavy cavalry and the resurgence of the infantry to a position of dominance, which they had lost with the disintegration of the Roman legions.

Organizational changes in almost all Western armies followed with even the French eventually choosing to fight on foot. The results demonstrated by the English archers and Flemish pikemen encouraged other countries to develop effective infantry based armies. Armies throughout Europe shifted from organizations that were based largely on smaller armies, mostly of nobles fighting as knights with a supporting cast, to larger armies based on commoners serving in infantry based organizations.

ATGM Use in the Arab-Israeli War of 1973

An example of an evolution in the continuing battle for dominance between the infantryman and a mounted force occurred with the development of the anti-tank guided missile (ATGM) in the 1940s. Before this time, all anti-tank weapons were “dumb” rounds. The ATGM marked a significant improvement over previous versions of anti-tank weapons. The Arab-Israeli War of October 1973 marked the first significant use of the ATGM in combat. The Soviet Union had provided Egypt several new weapons, two of which were the PTUR-61 “Snapper” and the PTUR-64 “Sagger” (AT-3 in NATO nomenclature) ATGMs.³⁶ To counter a superior Israeli tank brigade, the Egyptians developed new tactics and organizations to maximize the potential of these new weapons to counter expected Israeli tank counterattacks. The Egyptians formed special tank killing teams of infantry armed with Sagger ATGMs, mines, and RPG-7 hand-held anti-tank rockets. Once the Egyptians had crossed the Suez Canal, they established a defense with their tank killing teams, supported with mortar and artillery fire and tanks where possible. The Israelis attacked into the Egyptian defenses with almost pure tank formations, as it was the Israeli opinion that the desert conditions of the Sinai precluded a need for infantry support. Egyptians using ATGMs and anti-tank rockets, and supported by an air defense umbrella to counter Israeli aircraft, defeated the Israeli 190th Armored Brigade’s tank counterattack.³⁷

The ATGM’s impact did not serve as a genesis for a new form of warfare despite its apparent success. The ATGM did not spur revolutionary changes in land warfare. In the United States, the official opinion on the ATGM was guarded. General William Depuy, the United States

Training and Doctrine Command (TRADOC) Commanding General at the time, recognized the value of the ATGM to the Egyptian Army. However, he saw the lesson being not to rely on one combat arm, as the Israelis had done in the Sinai, but on a combined arms team to achieve victory. This lesson reaffirmed, not changed the direction the US Army was already heading with its new capstone manual. The U.S. Army's 1974 version of FM 100-5 *Operations* emphasized the infantry's more direct participation in the tank battle than had previously been the case. The new doctrine stressed employing infantry forces that could keep up with tanks to suppress enemy's anti-tank infantry, either from a mounted platform, or by dismounting the infantry from their carriers only long enough to dislodge the enemy anti-tank capable infantry by direct assault.³⁸

Link to United States' Revolution in Military Affairs

The last aspect of revolution and evolutions that must be explored is how the Javelin relates to the revolution in military affairs the United States is currently undergoing. There have been countless essays and articles written exploring this RMA. One of the most defining essays explaining the US military RMA came from its chief advocate during 1990s. Admiral William A. Owens, the Vice-Chairman of the Joints Chief of Staff from 1994-1996, chaired the Joint Requirements Oversight Council (JROC). This position placed him in a unique position guiding the US military through a new era of warfare. He saw the U.S. military's rapidly improving capabilities pointing toward a qualitative jump in the military's ability to use force effectively. He saw the RMA as a joint endeavor emerging from three general areas. The first area is intelligence, surveillance, and reconnaissance (ISR). It involves sensor and reporting technologies associated with intelligence collection, surveillance and reconnaissance. The second area is in command, control, communications, computer applications and intelligence processing (C⁴I). These advanced C⁴I technologies allow users to translate the awareness of what is occurring across a broad geographical spectrum into a common understanding of what is taking place there, and communicate that understanding quickly, surely, and accurately—in a usable

form to combat forces. The third general area is that of precision force. It is more than just precision guided weaponry. It includes a broader concept that emphasizes speed, accuracy, and precision in the use of all forces from infantry to strategic bombers.³⁹

Admiral Owens argues that it is the interaction of the programs within these general areas that causes the qualitative leap in military potential. He takes a page from Peter Senge’s book *The Fifth Discipline* and calls it “the creation of a new systems of systems.”⁴⁰ The new system of system is at the heart of the American RMA. The RMA’s realization depends upon the contributions and integration of all the military services and their systems. Figure 1 demonstrates the system of systems, their interactions, and what these interactions mean.

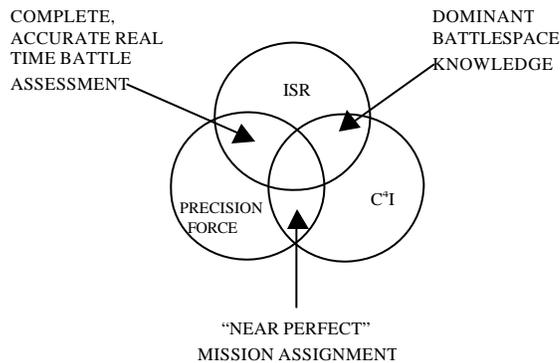


Figure 1 The American RMA: Emerging System of Systems⁴¹

Admiral Owens provides a partial list of weapons and systems that are either currently fielded or have been budgeted for and will enter the active inventory in the future. The list falls into the three general categories of ISR, C⁴I, and Precision Force. Listed among the Precision Force weapons and systems is the Javelin.⁴² He clearly sees the Javelin as one of the systems that is a subset of a greater system that together contribute to the RMA.

Can the Javelin be considered a separate revolution if it meets the criteria for revolution or should it be considered just part of the Army’s larger Revolution in Military Affairs? To answer that question thoroughly, in the following sections the Javelin’s fielding in the U.S. Army and Marine Corps will be explored to assess changes in organization, doctrine, potential adversary and ally reaction, and its potential impact on the modern battlefield.

Doctrine Review

In order to properly assess whether previous antiarmor, most particularly Dragon employment doctrine remains valid or needs changes, it is necessary to review the existing doctrine. The United States' doctrine for antiarmor weapon employment flows from both the United States Army and Marine Corps. Both services address employment of AT weapons in Infantry units.

In the Army and Marine Corps there exists limited sources of information concerning antitank, or antiarmor, weapon tactical employment. Within each service, two potential categories for sources of antiarmor doctrine exist. Such doctrine can be found either in specific antiarmor manuals such as the U.S. Army's Special Text (ST) 7-10-1 *Tactical Employment of the Javelin Antiarmor Section* and the Marine Corps Warfighting Publication (MCWP) 3-15.5 Coordinating Draft (CD) *Antiarmor Operations*. The other potential source of information is the manuals covering infantry units up to Brigade size in both the Army and Marine Corps. These manuals cover antiarmor operations to varying degrees. In researching the antiarmor warfare, it is necessary to assess and summarize antiarmor doctrine before the introduction of the Javelin and compare it to existing new antiarmor doctrine.

U.S. Army Doctrine

Within the Army's Infantry tactical series of manuals, that is Field Manuals (FM) 7-7J, 7-8, 7-10, 7-20, and 7-30, the predominant focus is on the dismounted infantryman against dismounted infantryman fight. Limited attention is paid to antiarmor operations throughout these manuals. The most recent manuals for employing the infantry rifle squad, mechanized infantry platoon, infantry battalion and brigade do not even mention how anti-tank (AT) weapons could be used in the offense. The evident trend in these manuals is that AT weapons have no useful roles in the offense and merit minimal consideration in the defense. Mention of the Dragon in support of defensive operations focuses on where to position AT weapons and what such a position should look like. In the armor-centric manuals (FM 71-1, 71-2, 71-3, 71-123) AT weapons, not including the tank, receive the same limited attention.

It is not until 1990 when the Army published FM 7-10 *The Infantry Rifle Company* does antiarmor weapon employment get serious consideration within an Infantry unit field manual. FM 7-10 devotes a thirteen-page section on employment of antiarmor operations. This section along with the Army's antiarmor unit employment manual, FM 7-91 *Tactical Employment of Antiarmor Platoons, Companies, and Battalions*, provides the foundation for understanding antiarmor unit and weapon employment. FM 7-10 states that concealment, cover, surprise, engagement criteria, and flank shots are the most important considerations for employing antitank weapons. Additional considerations the manual includes are dispersing, providing mutual support, and taking advantage of the standoff advantage of the TOW.⁴³ FM 7-91, though focused on units only equipped with the TOW, it serves as the primary reference that other Army manuals defer to for detailed discussion of the employment of antiarmor weapons.

FM 7-91 emphasizes that the key to employment of a unit's antiarmor assets is mass. The most valuable guidance the manual provides the Army is specifying in detail fundamentals for antiarmor unit employment. Those fundamentals are:

- Provide mutual support.
- Provide security.
- Strive for flank shots.
- Use TOW standoff.
- Use cover and concealment.
- Employ in depth.
- Employ as part of the combined arms team.⁴⁴

Since the introduction of the Javelin, the only significant contribution the Army has made concerning antiarmor doctrine has been to write Special Text 7-10-1, *Tactical Employment of the Javelin Antiarmor Section*. This text remains in draft format. The Infantry Center put this text together to support early users of the Javelin and provides this draft text to units as they receive their New Equipment Training.⁴⁵

This text currently is the Army's primary document for employing the Javelin. The text is a valuable source on the characteristics of the weapon, organization within light infantry units, and Javelin employment tactics. When compared to the tactics espoused in FM 7-91, there are many

similarities. No changes occur to organization structure in airborne, light, and air assault infantry units as a result of fielding the Javelin. The same structure that exists with units that have Dragons is the same structure that Javelin equipped units will have. Like FM 7-91, it provides fundamentals for employing Javelin. The following table compares the employment fundamentals as listed in FM 7-91 and those listed in ST 7-10-1.

FM 7-91	ST 7-10-1
Provide mutual support	Provide mutual support
Provide security	Provide security
Strive for flank shots	Strive for flank shot engagements
Use TOW standoff	Use Javelin standoff
Use cover and concealment	Use cover and concealment
Employ in depth	Employ in depth
Employ as part of the combined arms team	Employ as part of combined arms team
	Mass fires

Table 2 Antiarmor Employment Fundamentals⁴⁶

The parallelism between the two columns clearly demonstrates how closely Javelin employment principles have evolved from its predecessor, FM 7-91. The fundamentals according to ST 7-10-1 hold true with the Javelin as they did for the TOW with necessary modifications to account for the differences, primarily in range and lethality. Fire control principles and techniques remain the same between the manuals. The new manual clearly asserts that the Javelin is very similar to the Dragon and TOW in tactical employment, same basic tactics, no significant modifications or adjustments, just the Javelin can do it better.

Are there any new roles that ST 7-10-1 suggests that the Javelin may accomplish that the Dragon could not? ST 7-10-1 does break some new ground in means by which the Javelin could be employed. The text reflects that the Javelin does have new roles in which units could effectively employ it that other antiarmor systems could not do as well or would be unable to do. In support of screening operations, the Javelin element may provide early warning of approaching enemy formations, destroy enemy reconnaissance, deceive enemy reconnaissance forces as to the location of the main defensive positions, and delay enemy flanking maneuvers.⁴⁷ In the attack, Javelin elements can be used to destroy enemy armored units on the objective, destroy key enemy

positions slowing the momentum of the attack, engage counterattacking enemy vehicles, isolate the objective preventing enemy vehicles from reinforcing or withdrawing, and protect exposed flanks and block a developing or potential enemy attack.⁴⁸ The text does not discuss the potential role of the Javelin in a Movement to Contact, only stating its role would depend heavily upon the type of vehicles the enemy has, METT-T, and the commander's best judgement on how to use this asset.⁴⁹

ST 7-10-1 introduces an old idea with a new force. It encourages the leader to consider pushing Javelins forward of the main line in the defense. A forward Javelin force could engage the enemy's lead elements before they can engage forces in the main defensive area. Such an action could deceive the enemy to the location of the main force body, disrupt his formations, and cause him to employ an infantry force before reaching his objective.⁵⁰ Major James Morningstar wrote about using Javelins in such a fashion in his article for *ARMOR* Magazine in 1996 titled "Javelins and Skirmishers on the Battlefield." He contends that a well-trained Javelin element could perform the role of skirmisher on the modern battlefield. Through most of military history successful armies employed skirmishers on the battlefield forward of the main force for purposes of harassing, delaying, and disrupting enemy formations. Only with the introduction of effective indirect artillery fires and mechanization has the infantry relinquished the role of the skirmisher to artillery units that now perform that role. Major Morningstar asserts that the Infantryman, equipped with the Javelin, could now perform that mission more effectively than artillery.⁵¹

U.S. Marine Corps Doctrine

Within the Marine Corps, one manual, Fleet Marine Force Manual (FMFM) 2-11 *MAGTF Antiarmor Operations*, dated June 1992, clearly prevails in establishing doctrine and tactics for antiarmor warfare. FMFM 2-11 prescribes the tactics that Marine ground forces will employ for combating an armor threat. This manual is currently under revision with a coordinating draft currently existing, titled MCWP 3-15.5 Coordinating Draft (CD), *Antiarmor Operations*. Once complete this manual will supersede FMFM 2-11. The two manuals provide a valuable insight

into the Marine Corps' version of antiarmor doctrine from a pre-Javelin period to a Javelin era. It provides an important understanding examining the changes and potential evolution of antiarmor warfare doctrine and tactics.

FMFM 2-11 prescribes principles for employing antiarmor weapons that are similar to those found in the Army's FM 7-91 and ST 7-10-1. The essential points that the manual makes for antiarmor weapon and unit employment follow. Two methods of engagement for antiarmor weapons exist -- the HAW-MAW-LAW and the massed surprise fire methods.⁵² HAW-MAW-LAW refers to heavy antiarmor weapons (TOWs and tanks), medium antiarmor weapons (Dragons only in this text), and light antiarmor weapons (LAWs and AT-4s). For this method, the friendly force commander uses his antiarmor weapons to engage enemy armor forces at the maximum effective ranges for the different antiarmor weapons. The intent is to destroy enemy forces as far forward of friendly positions as possible. A tactical leader would normally employ this method against large armored formations. In contrast, the massed-surprise method of engagement is more appropriate for use against individual or small armor units ideally in an ambush situation. For this engagement technique, the friendly force simultaneously engages the enemy force with all his antiarmor weapons. It results in more initial kills on the first engagement, but at a much closer range.⁵³

Like the Army's antiarmor publications, FMFM 2-11 proposes several engagement factors for the friendly force leaders to consider while deciding how to employ his antiarmor weapons. He must consider the size of the enemy force, the terrain, the point of aim (frontal or flank shots on approaching enemy), and positioning to counteract enemy artillery fire (dispersion laterally and in depth if possible).⁵⁴ To position an antiarmor weapon, the leader must select a position that should provide protection and effect surprise while allowing the gunner to fire a lethal shot. The leader must consider the following factors when positioning his antiarmor weapons: cover and concealment of position, dispersion, ensure mutual support (includes security from light infantry threat), maximize standoff range, and seek flank shots.⁵⁵

MCWP 3-15.5 (CD) incorporates the Javelin into this new manual. An analysis of the new manual reflects the Marine Corps' apparent belief that no change to antiarmor doctrine or tactics is necessary with the addition of the Javelin to the Marine Corps' arsenal of antiarmor. The methods of engagement, engagement considerations, and positioning considerations remain unchanged. The manual includes some Javelin specific procedures to follow for using the weapon in the defense and the delay due to its unique characteristics. However, its roles and missions remain the same as when the Marine Infantry Battalions were equipped with Dragons instead. The manual, as does ST 7-10-1, includes more emphasis on the ability of the Javelin to support MOUT operations. This capability is largely due to its soft launch ability. The manual does fail to highlight the fact that Javelin has significant limitations of use within a MOUT environment if used in densely built-up areas, due to the long duration (10 to 40 seconds depending on gunner experience) it may take a gunner to achieve a lock on the target before being able to reliably fire the missile.⁵⁶ In complex terrain, such a long tracking time may be difficult to achieve. Reflecting the manual's incomplete consideration of the Javelin, its capabilities and employment potential, it incorrectly groups the Javelin with the TOW and Dragon in emphasizing that kill windows must be considered in selecting positions for these windows. The Javelin does not have a kill window, as the publication states, of 14.5 seconds to hit a moving target due to the Javelin missile time of flight to a range of 2000 meters.⁵⁷ What it actually has is a lock to fire window that can vary from 10 to 40 seconds depending on how long it takes a gunner to acquire a lock on his target before he may engage. After he fires, it does not matter if the vehicle moves into deadspace, from the gunner's perspective, because the missile continues to track the target until detonation.

Both FMFM 2-11 and MCWP 3-15.5 give little consideration to employing antiarmor weapons in the offense. Both manuals devote an in depth chapter on defense and delaying with antiarmor weapons, but barely give any mention to the use of antiarmor weapons during offensive operations other than a paragraph on hunter killer roles. Both manuals state "TOWs, and

Dragons [and Javelin in MCWP 3.15.5] have more utility in the defense than they do in the offense. There is more time to select and prepare positions to overcome obstacles which may interfere with the flight of the missile.⁵⁸ The Javelin largely nullifies the assertion that obstacles interfere with the flight of the missile since it is no longer wire guided like the TOW and Dragon and has a flight altitude of 60+ meters when firing in direct attack mode and 160+ meters when firing in the top attack mode. With the point for not having offensive doctrine for the Javelin having been countered, then it is reasonable to conclude that the Javelin can and should be used offensively as well.

Marine Corps doctrine pays little attention to a role for the Javelin in offensive operations. Captain John Hatala, USMC, emphasizes the point in his article “We’re not Ready for the Javelin”, which he wrote in 1999 for the US Naval Institute’s *Proceedings* publication. He asserts that the advanced antiarmor capabilities of the Javelin dictate a change in military doctrine. He believes the new doctrine should recognize the practicality and effectiveness of fire and forget missiles and planners should not underestimate the impact this factor alone will have on antiarmor warfare. He believes new doctrine must be developed further to exploit the Javelin’s capability to fight in an urban environment. Most importantly, he asserts the Javelin has great offensive capability, being the ideal weapon for the hunter killer mission. He cautions that if doctrine does not change, then units will not use Javelin teams offensively and the full potential of the weapon will never be realized.⁵⁹ Captain Hatala does not go into specifics for what the doctrine should state; only that it is needed and should be developed now. MCWP 3-15.5 (CD) does not appear to pay much heed to Captain Hatala’s call for new doctrine. Perhaps, before it becomes final, it will establish a doctrine for better capitalization of the Javelin’s potential as an offensive weapon.

Threat Analysis

In order to measure the potential impact of the Javelin, it must be measured against the best active protection systems for armored vehicles to assess whether or not it can defeat these

systems. The Javelin's tracking method uses an imaging infrared system for target acquisition and lock on. The Javelin gunner can take two specific actions, in addition to exercising patience to reduce the probability of countermeasures detecting the Javelin. The gunner can activate the Operator Selectable Filter on the CLU and wait to remove the Missile End Cap only once the decision is made to begin the engagement process.⁶⁰ By activating the Operator Selectable Filter, the CLU's infrared signature becomes obscured and almost impossible to detect by someone else looking through another infrared sight. By keeping the Missile End Cap on the end of the Javelin until beginning the engagement process, the gunner reduces thermal signature that an opponent could possibly detect with a thermal sight. The tandem warhead of the Javelin defeats all known explosive reactive and non-explosive reactive armor on modern battle tanks.⁶¹

ATGM Development

To be able to counter the Javelin and any other modern ATGM, an understanding of the different forms of guidance systems that ATGMs use is necessary. Since the Germans developed the first ground fired anti-tank missile in 1944, the X-7 Rotkäppchen, development of anti-tank guided missiles has continued, except for a four year lull at the end of World War II.⁶² First generation guidance systems, called Manual Command to Line of Sight (MCLOS), required gunners to guide their missiles into their target once they fired the missile. The guiding of the missile required a skilled and calm gunner to avoid making over corrections. In the late 1950s the French company SAT looked to make this an easier process for the gunner and developed a means of placing an infrared detector in the sight and connected to a computer scanner. The infrared detector would detect the infrared flame from the back of the missile and measure its deviation from the axis of the sight. The computer would then generate a correction, send it through the wire link to the missile and adjust it back into the sight axis line. All the gunner had to do was keep his sight on the target and the infrared system would do the rest. This second-generation guidance system has since been standardized and labeled Semi-Automatic Command to Line of Sight (SACLOS).⁶³ The vast majority of weapons currently on the market use some

variation of a SACLOS guidance system or a combination of the SACLOS and MCLOS.

Appendix 1, Leading Nations' ATGM Development, summarizes the most common medium range ATGMs in the world today.

Currently, only the Javelin and the Israeli GILL use third-generation guidance systems as part of a medium range manportable system, though others are sure to follow.⁶⁴ They both use an infrared thermal seeker, that locks onto the target before launch, and then, once the missile is launched, it automatically vectors itself onto its target, allowing the gunner to reposition or fire again. The third generation guidance systems are now in high demand throughout the world as many countries now attempt to develop their own or purchase systems from the United States and Israel. Recently, the United States approved the Javelin for Foreign Military Sales. The Netherlands and Spain have decided to make initial purchases of the Javelin requiring 240 and 12 systems respectively.⁶⁵

The Israeli GILL weapon system is one of three new Israeli ATGMs. The GILL will replace the Dragon in the Israeli Defense Force, along with its two big brothers, the NT-S SPIKE and the NT-D DANDY. The SPIKE replaces the TOW while the DANDY is designed for helicopter applications. The GILL's similarities to the Javelin are remarkable. Both use the same I2R principle with a thermal seeker. It maintains the same fire and forget characteristics of the Javelin. Some Israeli Defense Force units have already received the GILL and SPIKE.⁶⁶

Throughout the world, there exists urgency in nations' defense industries to develop or purchase ATGMs with third generation guidance systems. SACLOS alone guidance systems for ATGMs will eventually no longer be developed, despite resistance from many SACLOS ATGMs such as Euromissile's MR TRIGAT, with its "stone age" laser beam riding technology before even making it into a mass production stage. The ultimate destination for most Javelin missiles must also be examined to assess whether the capabilities of the Javelin provide its user a profound advantage in defeating modern battle tanks.

Most advanced nations now aggressively research better ways to protect their tanks. As the evolution of tanks and ATGMs continued their linked developments and improvement, the tank has gotten heavier and the ATGM more lethal. The solution of the past two decades for tank developers when faced with a new improvement in ATGMs was to add to its armor protection with the addition of more armor or reactive armor, and now explosive reactive armor. As ATGMs continued to become more lethal, just adding more armor and significantly increasing the weight of the tank beyond acceptable limits became a less than optimal solution. The Swedish made Bofors BILL took the first step among ground launched ATGMs to develop a technology that would attack the tank where its armament was the thinnest which was accurately assessed to be on top of the turret. The TOW IIb missile uses the same top attack via proximity sensor technology. Once this top attack means was established, it placed tank developers in a dilemma. Most tanks had already reached an excessive weight between sixty to seventy tons, and the desire now is to develop lighter, more strategically deployable tanks. Adding even more armor protection to tanks would increase the weight to largely unacceptable levels.⁶⁷ This dilemma contributed to developments in active protection systems (APS) for tanks.

Active Protection Systems

Many armies currently use various versions of active protection systems worldwide. The field continues to develop. For armored vehicles, active protection is a defense system designed to intercept, destroy or confuse attacking enemy munitions. They can be broken down into two categories, “active” or “hard kill” systems and “countermeasure” or “soft kill” systems.⁶⁸ An active or hard kill system engages and destroys enemy missiles or projectiles before they impact their intended target. It is a close in system of antimissile defense that creates a small buffer zone of protection around all or part of the tank. Countermeasure systems confuse or divert the inbound enemy missile with the use of obscurants, jammers, decoys, and signature reduction measures. Current APS systems are designed only to counter ATGMs and not tank fired munitions.

Although many countries have developed soft kill countermeasure systems, only Russia has developed a truly hard kill active system. They have produced two such systems, the *Drozd*, and now, the still under development *Arena* system. Russia currently leads all countries in mass producing both hard kill and soft kill systems. Its soft kill countermeasure system, the *Shtora-1* is widely regarded as the leading soft kill system in the world. Though numerous other countries, including the United States, are conducting research in this field or have fielded products with some similar capabilities, the *Arena* and *Shtora-1* represent the top of the field for hard and soft kill systems.⁶⁹ It is against this standard that the Javelin should be compared, for if it defeats these systems, it would in all likelihood, defeat all other nations' less capable systems as well.

The *Shtora-1* defense system was designed to increase the survivability of vehicles from attack from ATGMs with a SACLOS guidance system as well as from missiles and artillery projectiles that use laser illumination.⁷⁰ It is currently installed on the T80UK, T-80U, T-84, and T-90 main battle tanks and is offered for installation on other tanks during retrofit. It is currently available on the open market.⁷¹ The complete *Shtora-1* system consists of four essential components: 1) Electro-optical interface station consisting of the jammer, modulator and control panel. 2) A bank of forward firing grenade dischargers that is capable of firing grenades dispensing an aerosol screen. 3) Laser warning system. 4) A control system that processes the information from the sensors and activates the aerosol screen.⁷² The *Shtora-1* has a field of view of 360 degrees and -5 to +25 degrees in elevation

The laser warning system detects the threat laser system, either a range finder or laser designator, and automatically orients the turret in the direction of the threat, then triggers the grenade launchers that create an aerosol cloud. The screen takes about three seconds to form, lasts about 20 seconds and covers an area 50-70 meters.⁷³ The *Shtora-1* developers claim the cloud will screen the tank from lasers. This may be of limited value against another tank since the initial laser from the laser will have given the tank commander the correct range enabling it to fire at least one accurate shot through the smoke screen.⁷⁴ Against a laser guided ATGM such as

the TRIGAT, the cloud could potentially succeed in preventing the gunner from being able to track his target. Unless the tank moves away from his original line to the target, along which the system automatically fired the aerosol cloud, the ATGM is still likely to hit the tank. If the tank does move out from behind his cloud, he risks the ATGM gunner reacquiring him in time to guide his missile back onto the tank. Shtora-1's screen is also supposed to be sufficiently hot to draw infrared homing devices away from the tank.⁷⁵

The Shtora-1's electro-optical jammer, the TshU1-7, introduces a spurious signal over the 0.7 to the 2.5 Em band into the guidance circuitry of the incoming ATGM through the use of pulsed coded IR jamming signals that are continuously generated. The jammer provides coverage over 20 degrees on each side of the main armament and through 4 degrees in elevation, and is effective within two seconds of target identification. The electro-optical jammer is claimed to be effective against the TOW, HOT, MILAN, Sagger, and Dragon.⁷⁶ However, they make no claims of effectiveness against systems like the Javelin and GILL. Early SACLOS systems were extremely vulnerable to this jammer. The narrowness of the field of view of the system, both in elevation and azimuth, reinforces that the AT employment fundamental of 'strive for flank shots' remains valid even in this modern era.

The problem for tank designers and soft kill system designers is that there are multiple ATGMs in the world and they use various different guidance system variations such as laser, Xenon lamp, active millimeter-wave, and now fire and forget. The argument exists for developing detectors and jammers for all these systems, which causes tank developers to deal with a situation where the tank becomes overburdened with several expensive specialized systems. This is one reason why many nations are considering the alternative of an active defense, or hard kill system more closely.⁷⁷ Most Western nations have been reluctant to field soft kill systems in large quantities and they are even more reluctant to dive into hard kill systems. Nevertheless, with a new generation of ATGMs threatening the armored vehicles in

more challenging ways, hard kill systems are getting another look. Russia leads the field in hard kill systems.

Russia's Arena active defense system is the best in the small class of hard kill systems. The system is intended to protect tanks from antitank grenades and ATGMs and top attack munitions, including ATGMs launched from aerial platforms. When any of these munitions threaten the tank, the computer system automatically activates the active defense system with a reaction time of 0.05 seconds. The Arena system is fully automatic and provides a high degree of protection through about 300 degrees with a dead space to the rear of the turret. Mounted on the roof of the turret is a multidirectional radar sensor system, which constantly scans for approaching ATGMs and locates any target approaching within the designated speed band. After processing the data the computer selects the proper countermunition (CM) which is housed in 20 silos around the turret, and fires a small projectile into the path of the approaching ATGM. At the instance determined by the computer, the ammunition detonates 1.3 to 3.9 meters from its target, generating a directed field of destructive elements, which destroy or disable the target to levels that are no longer dangerous. After 0.2 to 0.4 seconds, the system is prepared to repel the next target.⁷⁸ The Arena is not susceptible to false firing caused by small caliber projectiles, targets outside the 50-meter buffer, or slow flying objects. It will necessitate the tank crew to fight buttoned up, and it poses a threat to unprotected infantrymen who may be within the 20-30 meter danger zone around the tank. The system operates in all weather and light conditions. Its manufacturer claims it is effective against the TOW, HOT, MILAN and Hellfire as well as the AT-4 and LAW 80. It remains in its prototype phase, with no known projected fielding date, with earliest possible date being no closer than five years.⁷⁹

The French and Germans have expressed interest in the Arena system, and *Jane's Armour and Artillery Upgrades Eighth Edition 1995-1996* stated that it is believed the Germans purchased a system for trial purposes.⁸⁰ Most Western armies are taking the approach that it is better to spend more on research in this area at present, and develop a system that combines, in a cost effective

way, hard and soft kill systems into an integrated defensive aids suite (DAS) that is controlled through the vehicle's computer. In the United States, such a system would most likely appear with the eventual introduction of the Future Combat System into the U.S. Army's inventory.⁸¹ ATGM technology will have an advantage over the main battle tank until integrated DASs have fully developed and become common on tanks.

No unclassified information regarding Javelin testing against any specific threat Active Protection Systems exists. However, the U.S. Army's Javelin Project Office does acknowledge that they have conducted testing, including live fire testing, against threat Active Protection Systems. They remain confident that the Javelin is immune to such systems at its advertised ranges largely due to its top attack profile and third generation guidance system. The Javelin is not immune at shorter ranges when using a direct attack profile against some ASP systems.⁸² Given the Javelin's third generation guidance system, top attack mode of attack and high trajectory, existing electro-optical jammers would have difficulty detecting and jamming the Javelin.

There have been no publicized APS tests against the TOW II, Javelin, or Israel's GILL or SPIKE. There also has been little reference to their ability to handle and destroy multiple targets simultaneously. Arena is still in its early stages, and Drodz and Shtora-1 are abundant, but have not proliferated extensively, despite their availability. These factors, in conjunction with other supporting facts, led Captain Tom Meyer to conclude in his article "Active Protection Systems: Impregnable Armor or Simply Enhanced Survivability" that active protection systems simply enhance survivability, and are not a solution to achieving an impregnable tank.⁸³ Modern ATGM technology, especially third generation ATGMs have a marked advantage. Though no military has yet to use the Javelin in combat, its testing during realistic training situations reinforces the point that the Javelin has a marked advantage in defeating an armored threat.

Operational Impact

During the Army Warfighting Experiment at the National Training Center in March of 1997, Javelin equipped light infantry units faced their first significant force on force test. The 1-5 Infantry Battalion was assigned to the Experimental Force (EXFOR) First Brigade, 4th Infantry Division from Fort Hood for this warfighting experiment that highlighted many of the new Force XXI systems of the U.S. Army. During this highly publicized rotation, a Force XXI unit faced its toughest challenge against the world class Opposing Force (OPFOR) of the National Training Center. Tasks for the light infantry included securing the flank for a mechanized attack, blocking a flank during a brigade defense, and attack to breach a lane in an enemy obstacle for the armor forces to pass through.⁸⁴ The commanders would use the light infantry to shape the battlefield, similar to the way the enemy would use a minefield or persistent chemicals to shape the battlefield to their advantage. The performance of the EXFOR was not marked by any discernible increase in lethality, survivability, or operational tempo as compared to the previous NTC rotations, against which observers compared the EXFOR's performance. Despite the overall average performance of the brigade, the Secretary of Defense's director of Operational Test and Evaluation, who with his team observed the majority of the rotation to provide an unbiased assessment for the Department of Defense, stated that his information indicates that the Javelin performed "very well" during the exercise and the light infantry task force "did very well" in fighting the heavier OPFOR.⁸⁵ During the rotation, the EXFOR did implement a new tactic for employing of the Javelin teams. They would successfully use UH-60s to move Javelin teams around the battlefield as mobile antitank snipers to successfully counter enemy armor threats.⁸⁶ When the next Javelin equipped unit came to the NTC, they would build upon these lessons.

The next significant test for the Javelin came in January and February 1999 when the Second Brigade of the 82nd Airborne Division deployed to the National Training Center for Rotation 99-04. They fought with two battalions of airborne infantry equipped with Javelins and an armor task force from Fort Riley. This rotation marked the first test for the Army where a light infantry

brigade equipped with Javelins instead of Dragons would face a world class OPFOR. The focus of the rotation would not be tank against tank battles, but light infantry against tank battles. The results were clear and indisputable in almost every case. The brigade had unprecedented success against the OPFOR, not only when compared to other light infantry brigades but when compared to most armored brigade rotations as well. Their success was largely due to their skillful employment of well trained and motivated Javelin AT teams. Going into the rotation, the Brigade Commander was confident that his brigade of well-trained paratroopers with Javelins could take on the OPFOR and win and they did on several occasions. The consensus among the leaders of the brigade, from company to brigade level, was that the Javelin “leveled the battlefield” between heavy and light units.⁸⁷ All commanders agreed that the Javelin was the item that made the light infantry effective. The leaders and soldiers were convinced that the Javelin afforded the soldiers an “unbelievable increase in survivability with fire and forget” technology. Most engagements involving Javelins were one sided with the Javelin gunners scoring multiple kills on OPFOR armored vehicles. Commanders stated that their primary tactical consideration was how to get the Javelin into the fight and keep it there with enough rounds to keep it effective. The Javelin had met or exceeded their expectations, although their expectations were already very high after having observed their recent Javelin live fire during which their gunners hit 29 out of 30 targets.⁸⁸

So what was it about how the infantry battalions employed their Javelin teams that made them so successful? The leaders of the brigade employed the Javelin as part of a combined arms team. It alone did not achieve success, but was successfully integrated with other systems to enable success in the hands of capable leaders and skilled gunners.

The brigade did not employ the system the same way they would a Dragon. They developed new tactics, techniques, and procedures to add to existing anti-tank doctrine. New observed uses during defensive missions included developing means to increase the mobility of Javelin teams. The Javelin gunners proved themselves too valuable to be left out of the fight if the enemy

decided to go a different way and try to avoid them. Thus, leaders had to plan for rapid repositioning of Javelin teams and additional missiles by either wheeled vehicle or air. This flexible use of Javelins often meant creative task organizations would occur, such as a battalion's worth of Javelin teams being re-task organized to fall under brigade control to block an unexpected penetration in another area of the brigade's sector. The disadvantage for the Javelin gunners to having to be prepared for the rapid repositioning was that it demanded less than optimal dispersion between Javelin teams and their additional rounds, so that they could quickly consolidate to begin their movement. The Javelin's thermal site proved valuable for use as a reconnaissance, surveillance, and target acquisition tool, since it was the most capable night vision device within the infantry companies.⁸⁹

During offensive missions, the Javelin proved effective as well because it was "quick and flexible, and the enemy did not see it coming."⁹⁰ New tactics observed included aggressively infiltrating infantry companies the evening before a movement to contact to shape the battlefield for the next morning's fight. This tactic is not new, but the task and expectations significantly rise when the force being inserted includes Javelin teams. Infantry company tasks included securing Javelin teams and carrying their additional missiles. During the enemy's armored attack the next morning, tasks for these forward positioned Javelin-equipped units included destroying lead enemy companies, or blocking enemy avenues of approach, which are tasks that would most often not be realistically assigned to infantry companies that were only equipped with Dragons. In one attack, one company reinforced with two additional Javelins (eight total) destroyed 60 vehicles of the enemy's advanced guard main body with the help of a helicopter resupply of missiles.⁹¹ Such aggressive use of the Javelin teams also meant developing aggressive means to resupply the companies with additional missiles. The brigade had to develop responsive means to push additional ammunition forward. At the battalion level and below, leaders solved this problem by committing HMMWVs to each company to push missiles forward. At the brigade level dedicated aviation assets were used to push Javelin ammunition and repair parts forward.⁹²

Dispersion continued to be a problem for Javelin teams in the attack as well as during the defense. The Javelin manual ST 7-10-1 recommends 300 meters between Javelin teams, but often company Javelin teams would be consolidated to facilitate fire control. The challenge Javelin teams must overcome is how to maintain dispersion while remaining responsive to changes in planned fire control measures that are necessary due to enemy actions. Only the weapon squad leader's radio in each platoon is available to assist in overcoming this problem. A concentration of Javelins becomes a lucrative target for the enemy to destroy with indirect or direct fires.

The impact of the Javelin was felt on the National Training Center's OPFOR as well as they developed methods to try to neutralize the advantages the Javelin gave their opponent. During the Second Brigade, 82nd Airborne Division rotation, the OPFOR tried to template where Javelin teams would be positioned on the battlefield. They would draw two-kilometer radius circles around these positions and attempt to avoid them with their armored formations. If they did detect the Javelin teams, they would try to fix the teams so that they could not relocate on the battlefield. If they could not avoid the positions, they would decide which one was the weakest, fire a non-persistent chemical at the position followed by massive artillery strikes. Once the non-persistent had dissipated, they would attack with light infantry to clear the area. They would use this location as their point of penetration and avoid all other templated Javelin positions.⁹³ The OPFOR would assign a high priority among its reconnaissance objectives to identify Javelin teams. The OPFOR would combat the Javelin with combined arms, first to find them and establish surveillance on them, and then to attack them, if unavoidable, with infantry and artillery and occasionally with helicopters.⁹⁴

The Javelin has clearly made an impact under what the U.S. Army considers the most realistic conditions that can be replicated short of actual combat. A former Senior Light Task Force Trainer at the National Training Center stated in his 1996 article in *ARMOR* magazine that the Dragons of light infantry battalions' normally have little effect on the battlefield unless they mass

their fires.⁹⁵ Today, two Javelin equipped infantry platoons can induce as much destruction as a light infantry battalion's worth (18) of Dragon gunners can.⁹⁶ With such an increase in lethality and protection, due to its fire and forget technologies, the realm of missions that can be asked and expected of Javelin equipped units greatly increases.

Conclusions and Recommendations

The introduction of the Javelin to the U.S. Army's light infantry battalions clearly indicates the potential for a revolution in ground armored warfare. The Javelin is a vital system of the precision force needed as part of the United States Revolution in Military Affairs. Analysis of existing antiarmor doctrine illustrates that only minimal changes have occurred since the introduction of the Javelin, and that doctrine insufficiently exploits the Javelin's full potential. Allies and potential adversaries are striving to develop or purchase third generation ATGMs. Active Protection System research is on going in many countries, including the United States. The Javelin can defeat all known APSs currently fielded at disclosed ranges and provides the Javelin gunner a marked advantage on the battlefield. As the Javelin is fielded no changes occur to organizational structures, but its emergence enables (in conjunction with numerous other new or improved systems) radical changes in combat unit organizations to occur as part of U.S. Army's ongoing revolution in military affairs.

The military must take further steps to capitalize on the capabilities the Javelin provides. The recommendations are captured within the TRADOC recommended warfighting requirement domains of doctrine, training, leader development, organization, materiel, and soldier (DTLOMS).

Doctrine

The U.S. Army must commit to expanding the existing warfighting doctrine associated with Javelin. Revisions to the infantry series of manuals await the publication of the new U.S. Army capstone manual FM 3.0 *Operations* before the Infantry Center completes its revisions on the infantry company, battalion, and brigade tactics manuals. The Armor Center must ensure its next

set of revisions to its company, battalion, and brigade level manuals include more detail in how to employ light and mechanized infantry units equipped with Javelins. The heavy-light appendix included in each of these manuals must reflect an expanded list of potential missions that higher headquarters could now ask of light infantry units and expect them to be able to accomplish.

Expectations at end-state of a mission should reflect the increased lethality and protection that Javelin equipped units now have. No longer should infantry companies infiltrate during an attack merely to destroy a mechanized platoon to create a penetration for a heavy force. Now they could accomplish a task such as attack a mechanized or armor company to force them to displace from their primary positions before the heavy force attack. A Javelin equipped force could also be assigned the mission to locate the enemy armored forces in their hide positions and attack to destroy enemy forces once they move from their hide positions in order to prevent the enemy from massing fires on an approaching armor force. The possibilities are too numerous to list them all. The point remains that all U.S. Army, especially infantry and armor warfighting manuals, and U.S. Marine Corps warfighting publications must expand the roles and missions for a light infantry force against an armored threat both in the defense and, especially, in the offense. ST 7-10-1 and Major Morningstar's article "Back to the Future, Javelins and Skirmishers on the Battlefield" are a great place to start in developing new and innovative ways of employing Javelin equipped light infantry.

Senior leaders must realize the impact the Javelin will have on the tempo of a battle. FM 3.0 *Operations* (DRAG Edition) defines tempo as the rate of military action. Controlling or altering that rate is a necessary means of retaining the initiative. A faster tempo allows attackers to disrupt enemy defensive plans by achieving results quicker than the enemy can respond.⁹⁷ It states it should be a characteristic of any offense mission. The manual emphasizes that a rapid tempo is essential in order to prevent the enemy from having time to react to your actions. Until the point when even light infantry forces have transformed into more mobile forces, the Javelin will not be a weapon that will increase tempo. In many cases, the Javelin will slow tempo of a

force, in both the offense and the defense. What is more important than a rapid tempo, however, is to be able to control the tempo, to be able to control the rate at which both yours and your opponents actions occur. The Javelin must not be discounted because it lacks tactical mobility in the hands of light infantry. It is too valuable a weapon. Therefore, planners must give deliberate thought to overcome this weakness.

In the defense, tempo remains critical though FM 3.0 does not identify it as a characteristic of the defense. Yet, changes will result in the tempo to operations in the defense. One characteristic that was common to all force on force battles during the Second Brigade of the 82nd Airborne Division's NTC rotation in January to February 1999 was that all the battles took much longer than the average force on force battle in previous rotations, sometimes twice as long.⁹⁸ The enemy was more deliberate and often times more uncertain. The Javelin equipped commander has more control over the tempo of the battle. He can increase or decrease the tempo based upon actions of his subordinate units. As evidenced during this rotation, the enemy may often have no choice but to deal with the Javelin force threat, which will require more time since it will most likely involve more artillery and especially more infantry. The best way to defeat a Javelin equipped unit is not with an armored force but with another light infantry force. The process will be slow and deliberate.

In the German Army at the end of World War I discussion of how best to employ the new weapon of the tank on the battlefield flourished in German professional journals and military circles. These professional discussions and debates initiated and nourished by such pioneers in armored warfare as Ernst Volckheim, Oswald Lutz, and Alfred von Volland-Bockelberg were the seeds from which German blitzkrieg tactics developed in the 1920s and 30s.⁹⁹ Today in the U.S. military, we must strive to foster the same professional discussion on employment of the Javelin in our military professional journals. To date only five articles have been written for publication in the U.S. Army's *Infantry* and *ARMOR* magazines and the U.S. Marine Corps' *Marine Corps Gazette* concerning the tactical employment of Javelin equipped units.¹⁰⁰ Such discussion and

debate on the topic must increase in order for Javelin employment doctrine to grow and evolve. The infantry and armor communities have much to gain by promoting and focusing this discussion. The Center for Army Lessons Learned (CALL) must begin to capture the lessons from units now employing the Javelin, develop TTPs for all the U.S. Army to use, and distribute those throughout the Army for the benefit of all.

Training

The average soldier could not pick up the Javelin and expect to be able to hit his target without any prior training. Nor could the Army expect him to hit his target if he only trains on the system one day a year. Like many of the new systems with advanced technology, it requires training that must be sustained to ensure gunners remain proficient in the system's operation. Currently the 82nd Airborne Division is experiencing a drop in Javelin gunner proficiency due to many of the original gunners rotating to other assignments.¹⁰¹ The Army has realized this problem and has developed a multimedia sustainment-training plan for units to use to ensure gunners remain proficient at operating the system. Such a sustainment program should alleviate some of the proficiency drop off, but will not solve it all. In order to ensure Javelin skills remain high, the U.S. Army should take additional steps.

Every infantryman at the battalion level and below must know how to operate the Javelin, not just the gunners. The Infantry Center is developing a Javelin Gunners Skill Test and will include it as part of the new manual FM 23-37 *Javelin* that the Infantry Center is now writing. This manual focuses on Javelin training and not tactical employment. Similar to the Bradley Gunner Skills Test that every Bradley Fighting Vehicle crew member must take prior to participating in a crew live fire, biannually, or when crew members have changed positions, every Javelin gunner should take a Javelin Gunner Skills Test at least every six months in active duty light infantry units.¹⁰² Infantry units should be encouraged to attain a higher standard and have all infantrymen trained on the system and take the test as well. Such a test would sustain Javelin skills not only in assigned gunners but in all infantrymen, so that every member of an infantry company could

successfully operate a weapon that would arguably be of more value to him than his personal weapon in combat against an armored enemy. Such an understanding by all soldiers will increase the lethality of infantry units on the battlefield where casualties are often unavoidable. An understanding by all soldiers will lead to better tactical employment, and more innovative methods of employing the system. It is an investment in the future. Training young soldiers, who five to ten years from now will be Weapons Squad Leaders and will be expected to be experts in all technical and tactical aspects of the Javelin system, will exponentially improve the employment of the system both today and in the future. The Infantry Center has taken another step and has included the task of “Prepare the Javelin for Firing” as part of its Expert Infantryman Badge training and testing for units equipped with the Javelin.¹⁰³

The U.S. Army must also endeavor to ensure that future combat simulators include Javelin teams. The inclusion of Javelin teams in combat simulators that are normally dominated by armored vehicles will facilitate the integration of the Javelin into the combined arms team and provide an ideal opportunity for leaders to learn how to employ this new weapon. Such simulations must be developed to facilitate everything from a weapon squad leader's controlling the direct fires of his Javelin teams to a brigade commander being able to employ Javelin units. Current simulations that are fielded as part of the Javelin system, the Basic Skills Trainer and the Field Tactical Trainer, are excellent tools for training the gunner. However, they do not provide the opportunity for integrated collective simulation training as such simulators as the U.S. Army's Platoon Gunnery Skills Trainer and SIMNET trainers for training at the platoon through brigade level for armored and mechanized forces.

Leader Development

To increase leader proficiency in employing Javelin equipped units, combat leaders must become better educated on the technical and tactical employment aspects of the system so that its full potential may be realized. To accomplish this development two steps should be taken. First, include lessons on tactical employment considerations of the Javelin for leaders from squad

through battalion level as part of the New Equipment Team's training. Currently, a civilian contracted team conducts training on the technical aspects of the Javelin, but nothing on tactical employment as a collective task, thus leaving a void between having skilled gunners and untrained leaders. Such tactical training must include squad leaders, platoon leaders, company commanders, and battalion commanders. Secondly, the Infantry School's Programs of Instruction for the Pre-Command Course for new battalion and brigade commanders, Infantry Officer Basic Course, Infantry Captain Career Course, Basic Noncommissioned Officer Course, and the Advanced Noncommissioned Officer Course must include a characteristics, capabilities and tactical employment classes on the Javelin. The Armor School should also include this instruction in its officer courses as well. Such instruction would significantly increase the knowledge of the Javelin system among leaders at the tactical level, which would most likely lead to improvements and innovations to existing Javelin tactical employment doctrine.

Organization

The organization of the light infantry platoon, company, battalion, and brigade is organized to handle capably a wide spectrum of missions, many of which may not be against an armored threat. Significantly changing the base organization of the infantry battalion to exchange riflemen for additional Javelin gunners would, in most likelihood, hurt the infantry units overall capability. Considering that FM 525-5 *Force XXI Operations* (Draft) assesses most likely future threat being asymmetrical and not a conventional force, it would be unwise to significantly change the flexible infantry organization that currently exists to make it more lethal against a conventional threat at the cost of inhibiting its ability to handle other threats.¹⁰⁴ The challenge is to determine how to provide light infantry units the capability without a cost of losing other needed capabilities. The answer to this question can be found by examining the infantry battalion model currently being developed and organized for the U.S. Army's Interim Brigade Combat Team (IBCT) at Fort Lewis, Washington. In these infantry battalion organizations, each nine-man infantry squad is assigned a CLU for its use as required. If the squad does not need the Javelin, then it remains

stored in the squad's vehicle. The squad maintains the CLU and trains on it in order to retain proficiency with the system. Additionally, each infantry platoon's weapon squad should have two two-man Javelin teams. These soldiers would retain a higher level of proficiency on the Javelin system and could more easily be task organized within a battalion to best suit the commander's plan. If the situation did not warrant the use of Javelin teams, the team members would serve as ammunition bearers for the two machine gun crews in the weapon squad. Original organizational models for the IBCT force included the additional Javelin teams in each weapons squad, but the teams were later removed from subsequent organizational models in order to ensure all platoon members could still be carried in the platoon's vehicles. It was more a space than capability issue.¹⁰⁵ With a CLU in each rifle squad, an IBCT infantry battalion has 27 Javelins, versus 18 Dragons in today's legacy force light infantry battalions. With the marked increase in lethality of the Javelin over the Dragon, if each gunner fired his basic load of six missiles each, the IBCT light infantry battalion could potentially kill 145 vehicles compared to a legacy force battalion's 21 kills, for a resulting ratio of 6.7 to 1. That marked difference truly signifies a major reason why the backbone of the Objective force will be the infantryman and not the Future Combat System. The Future Combat System is merely the enabler. The U.S. Army's Objective Force demonstrate the paradigm shift about to occur in our military where the infantryman returns to his place of dominance on the battlefield, just as he had done in the Infantry Revolution of the 1300s when he ended the heavy cavalry's dominance of the battlefield.¹⁰⁶

Material

The Javelin is clearly a quantum leap ahead of existing armor vehicle active protection systems and third generation fire and forget technology has left the remaining developers of first and second generation ATGMs scrambling to justify their existence and prevent their unavoidable extinction. However, as technology continues to develop in active protection systems, and any possible operational enhancements become evident after fielding, the Javelin must also evolve to

maintain its advantage. One significant advantage the Javelin has is that it consists both of hardware and software and updating software is not nearly as expensive as having to replace an entire system. Currently the U.S. Army's Javelin Project Office continues to research enhancements to the Javelin system to ensure it maintains its advantage on the modern battlefield. The Project Office currently focuses primarily on Javelin improvements in four areas: 1) They are researching methods of enhancing the Javelin's Counter Active Protection System (CAPS) to ensure its high probability of kill as APSs evolve. 2) They are developing enhancements to the CLU to provide it more magnification and improve clarity to farther ranges. 3) They are researching a multi-mode warhead that increases the possible uses and lethality of the Javelin missile in urban environments. 4) Lastly, they are researching the integration of the Javelin with the Land Warrior System.¹⁰⁷

The U.S. Army must continue to invest in the Javelin system and fund research for improving an outstanding weapon. The Javelin will most likely maintain its advantage over any Active Protection System for the next ten to fifteen years. At that point, APS technology could possibly be advanced enough to defeat the Javelin missile. That point can be delayed or may never arrive if the U.S. military remains committed to maintaining its advantage by continuing to develop enhancements to the Javelin and other fire and forget technologies such as the Fire and Forget TOW.

Soldier

The Javelin is a powerful system, but in the hands of an untrained soldier, it is worthless. The Javelin should be a weapon that every infantryman can be capable of using, not just specially trained gunners. The U.S. Army must continue with its primary emphasis on equipping the soldier and not on manning the equipment. Merely having the equipment does not, by itself, equate into a capability. The trained, competent, and well lead soldier with the right equipment fighting as part of a combined arms team will make the difference.

The Javelin is not an Excalibur that miraculously brings victory to the side who possesses it. Its introduction does not bring with it a call to turn in all tanks and issue the tank crews a CLU and two missiles. The Javelin does mean that Javelin equipped Infantry units must now be given far more consideration by their adversary in an armored warfare scenario than they ever have been in the past. Doctrine must further evolve to inculcate the new increased capabilities infantry units will now have in many scenarios. The Javelin's lethality and marked advantage over any Active Protection System reaffirms the direction the U.S. military is heading in its current Revolution in Military Affairs and with its reorganizing the Army and placing increased emphasis on well equipped and well trained infantry forces that are mobile, both at the tactical and strategic level, lethal and capable of decisive operations. Armored forces will not go away, and they never should, but the balance of power is shifting back to the infantryman.

Appendix 1 Leading Nations' ATGM Development

Weapon	Origin	Year Fielded	Guidance System	Range	Missile to Sight Link	Method of Attack
Javelin	USA	1996	Passive Imaging Infrared	2500 m	Automatic Self-guiding	Top Attack or Direct Attack
Dragon	USA	1975	SACLOS	1000 m max 65 m min	Wire	Direct Attack
AT-4 Spigot	Russia	1973	MCLOS & SACLOS (IR flare)	2000 m max 70 m min	Wire	Direct Attack
AT-7 Saxhorn	Russia	Early 1980s	SACLOS (IR flare)	1500 m max 80 m min	Wire	Direct Attack
MILAN 3	France	1995	SACLOS (Xenon Lamp)	2000 m max 20 m min	Wire	Direct Attack
MR TRIGAT	UK, France, Germany	2002 projected	SACLOS (Laser)	2400 m max 200 m min	Laser Beam	Direct Attack
Bofors BILL 2	Sweden	1999	SACLOS	2200 m max 150 m min	Wire	Top Attack (via proximity fuse) & Direct Attack
NT-G GILL	Israel	1998	Infra-red thermal seeker	2500 m max	Automatic Self-guiding	Top Attack
Eryx	France	1991	SACLOS (Xenon lamp)	600 m max 50 m min	Wire	Direct Attack

Table A-1 World Top Medium-Range Anti-Tank Guided Missiles¹⁰⁸

The Israeli SPIKE and DANDY have already broken new ground with an innovative guidance solution, surpassing the GILL and Javelin in their guidance systems. The new guidance systems are not actually new but the combination of second (SACLOS) and third (fire and forget) generation guidance systems. These ATGMs can be fired either way or the gunner may switch in mid-flight of the missile if he desires. The missile retains a fiber-optic wire link back to the tracker through which the gunner can override the built-in guidance system of the missile. This unique combination provides the gunner maximum flexibility in selecting the best attack profile

depending upon the nature of the target, environmental conditions, and presence of countermeasures. The gunner may elect to use the SACLOS guidance method if the seeker of the missile is having difficulty acquiring or tracking the target. This new guidance combination allows the gunner to fire the missile in the fire and forget mode, then regain manual control if, while during the missile's flight, the target is identified as a decoy or hulk, or a higher priority target appears in the missile's field of view, or countermeasures cause the missile to lose its lock on the target. These missiles can be fired either in a lofted trajectory like the Javelin and GILL with a top attack profile or in a line of sight trajectory.¹⁰⁹ The disadvantage to the new tracking systems on the SPIKE and DANDY is that in order to be able to allow human intervention during the flight of the missile; the missile has a comparatively slow cruise speed (150-180m/sec). Such a slow velocity allows the gunner time to manipulate the missile's tracking, but provides more time for potential countermeasures to be implemented.

Like the Javelin, international interest in the Israeli NT ATGM family is robust. Poland may purchase the NT-D DANDY. The company that makes the NT ATGM family actively markets the weapons throughout much of the world. The Netherlands, along with its Javelin purchase has also purchased GILLs to equip its new Airmobile brigade with both Javelins and GILLs. Since the US has yet to develop a replacement for the TOW, the SPIKE is easily filling the vacuum as nations strive to progress beyond the "stone age SACLOS technologies."¹¹⁰ The MR (Medium Range) TRIGAT, a European joint venture which uses a SACLOS laser beam riding guidance technology, is facing technical difficulties and has delayed fielding dates. Consequently, many countries such as Germany, United Kingdom, Finland, and Norway are taking a harder look at the GILL, SPIKE, and Javelin.¹¹¹ In January 1999, a combined Finnish/Norwegian Army conducted a three-week user trial to determine which medium range ATGM they would purchase for their army. The five ATGM systems evaluated were the Bofors BILL 2, the MR TRIGAT, the MILAN 3, the Javelin, and the NT-G GILL (sometimes called the Short SPIKE). Jane's Defense Weekly reported that this test was the "most demanding and best-run ATGW trial ever carried out

by a user....”¹¹² The Finnish Army selected the Israeli SPIKE system for reasons that weighed factors of price, training, manageability, capacity of sensors, jamming resistance capacity, suitability for Finnish terrain and weather. The new weapon for the Finnish army will be called the Spike 2.5 and will be built in Germany by Euro-Spike with assistance from its Israeli originating company RAFAEL Armament Development Authority. It will essentially have the characteristics of the SPIKE with a maximum range of 2500 meters, and fire and forget or fire, observe, and override guidance options.¹¹³

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- ⁵⁹ Captain John W. Hatala, “We’re Not Ready for the Javelin,” *Proceedings* (Dec 1999): 74-75.
- ⁶⁰ ST 7-10-1, 17.
- ⁶¹ Major John C. Hinds, Assistant Project Manager Javelin - Product Developments, telephonic interview by author, 02 November 2000.
- ⁶² Ian Hogg, *Tank Killing* (New York: Sarpedon, 1996), 170-172.

⁶³ Ibid., 174-175.

⁶⁴ India and Russia also use 3rd generation ATGM, just not from a man portable platform. The Russian's third generation ATGM, called the KHRIZANTEMA, is now in production. This is a long range (5-6 km) ATGM that is mounted on a vehicle platform. The weapon uses a radar detection and tracking system, which makes it unique. It is fire and forget capable, however it must maintain an electronic line of site with the target for the duration of the engagement sequence, and thus it can not take cover immediately after missile launch. ["3rd Generation ATGWs: The Russian Outlook." *Military Technology*. Volume 22, Issue 2 (February 1998): 34-35.]

⁶⁵ *Army Technology – Javelin – Anti-Armour Missile*, Online, Net Resources International (Available: <http://www.army-technology.com/projects/javelin/index.html>), 3 August 2000.

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⁶⁷ Ian G S Curtis, "The Most Powerful Enemy of a Main Battle Tank...," *Defense and Foreign Affairs Strategic Policy*, Volume 26, Issue 11/12 (November/December 1998): 7.

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⁷⁰ Tony Cullen, and Christopher F. Foss, ed. *Jane's Armour and Artillery Upgrades; Eighth Edition 1995-1996* (Great Britain: Biddles Ltd., Guildford and King's Lynn, 1996): 251.

⁷¹ Meyer, 10.

⁷² *Jane's Armour and Artillery Upgrades; Eighth Edition 1995-1996*, 251.

⁷³ Meyer, 8.

⁷⁴ Curtis, 9.

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- ⁸⁴ “Armor’s Assassins,” *ARMY*, Volume 47, Number 6 (June 1997): 32.
- ⁸⁵ George C. Wilson, “EXFOR performance comes under scrutiny,” *Army Times* (26 May 1997): 3.
- ⁸⁶ “Armor’s Assassins,” 30.
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- ⁸⁹ Major Bradley N. McDonald, and Major Steve Reed, “Lessons Learned From 2nd BDE, 82nd ABN DIV, NTC ROTATION #99-04,” Javelin Project Office (March 1999): 1.
- ⁹⁰ “82nd Airborne Division NTC Javelin Debrief,” 2.
- ⁹¹ Terry Whiteford, “SMI Brief- Javelin Overview,” PowerPoint Briefing (March 2000), Slide 13 and personal witnessing of the accomplishment as the observer-controller of the company that accomplished the task.
- ⁹² “Lessons Learned From 2nd BDE, 82nd ABN DIV, NTC ROTATION #99-04,” 2.
- ⁹³ “NTC OPFOR Lessons Learned (Javelin),” 1.
- ⁹⁴ Ibid.
- ⁹⁵ Colonel Frank Stone, “Heavy-Light Operations At the National Training Center,” *ARMOR* (November-December 1996): 40.
- ⁹⁶ Calculation is based upon a calculation of 6 missiles per gunner and a probability of kill for the Javelin of 0.9 and a probability of kill for the Dragon of 0.2.
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¹⁰⁷ Hinds, telephonic interview and “SMI Brief- Javelin Overview”, Slides 28-30.

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