ARMY DIRECT FIRE ACCURACY: PRECISION AND ITS EFFECTS ON THE BATTLEFIELD

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One of the common practices of modern warfare is the development of new weapons based upon advances in technology. As these weapons evolved during the twentieth-century, the United States Army witnessed significant improvements in the accuracy of its direct fire weapon systems; soldiers who fired rifles, armored guns, and antitank missiles experienced an increased ability to hit what they were aiming at and do so at greater ranges. Understanding the factors driving the Army to develop precision weaponry is key to this analysis; in addition to providing an efficient means of executing warfare, the Army is subject to external pressures from the American public to limit collateral damage and fratricide. Innovations in Army direct fire weapon systems will have a significant impact on the way future wars will be fought, especially when these advances are combined with the accuracy of precision indirect fire assets from the Army and precision guided munitions from the Air Force. These changes will affect individuals, units, and in several ways the entire Army as it evaluates its tactics, doctrine, and organizational structure in the midst of developing increasingly accurate direct fire weapon systems.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

ARMY DIRECT FIRE ACCURACY: PRECISON AND ITS EFFECTS ON THE BATTLEFIELD, by MAJ Christopher J. Kidd, 75 pages.

One of the common practices of modern warfare is the development of new weapons based upon advances in technology. As these weapons evolved during the twentieth-century, the United States Army witnessed significant improvements in the accuracy of its direct fire weapon systems; soldiers who fired rifles, armored guns, and antitank missiles experienced an increased ability to hit what they were aiming at and do so at greater ranges. Understanding the factors driving the Army to develop precision weaponry is key to this analysis; in addition to providing an efficient means of executing warfare, the Army is subject to external pressures from the American public to limit collateral damage and fratricide. Innovations in Army direct fire weapon systems will have a significant impact on the way future wars will be fought, especially when these advances are combined with the accuracy of precision indirect fire assets from the Army and precision-guided munitions from the Air Force. These changes will affect individuals, units, and in several ways the entire Army as it evaluates its tactics, doctrine, and organizational structure in the midst of developing increasingly accurate direct fire weapon systems.

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ACRONYMS

ABCS	Army Battle Command Systems
ACR	Advanced Combat Rifle
AICW	Advanced Infantry Combat Weapon
ARL	Army Research Laboratory
ATGM	Antitank-Guided Missile
BRM	Basic Rifle Marksmanship
CCO	Close Combat Optic
CEP	Circular Error Probable
CS	Combat Support
CSS	Combat Service Support
DCX	Division Capstone Exercise
DGDP	Directorate of Graduate Degree Programs
DOD	Department of Defense
ETAC	Enlisted Terminal Attack Controller
FLIR	Forward Looking Infrared System
GDP	Graduate Degree Programs
GMLRS	Guided Multiple Launch Rocket System
GWOT	Global War on Terrorism
HBCT	Heavy Brigade Combat Team
IBCT	Infantry Brigade Combat Team
IMU	Inertial Measurement Unit
JDAM	Joint Defense Attack Munition
JSSAP	Joint Service Small Arms Program

ITAS	Improved Target Acquisition System
LAMPS	Light Airborne Multipurpose System
LGB	Laser-Guided Bomb
LMTS	Laser Marksmanship Training System
MEDEVAC	Medical Evacuation
MLRS	Multiple-Launch Rocket System
NTC	National Training Center
NVD	Night Vision Device
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PGM	Precision-Guided Munition
PGMM	Precision-Guided Mortar Munition
PGW	Precision-Guided Weapon
R&D	Research and Development
RMA	Revolution in Military Affairs
RPG	Rocket Propelled Grenade
SACLOS	Semiautomatic Command to Line of Sight
SDM	Squad Designated Marksman
SEAL	Sea, Air, Land
SEP	System Enhancement Program
SPIW	Special Purpose Individual Weapon
TOW	Tube-Launched, Optical-Sighted, Wire-Guided
TTPs	Tactics, Techniques, and Procedures
USCG	United States Coast Guard

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CHAPTER 1

INTRODUCTION

A common practice of modern warfare is the development of new weapons based upon advances in technology; the twentieth-century American military is an excellent example of this trend. As these weapons evolved during this time period, the United States Army witnessed significant improvements in the accuracy of its direct fire weapon systems; soldiers who fired rifles, armored guns, and antitank missiles experienced an increased ability to hit what they were aiming at and do so at greater ranges. Contributing to this trend during the post-World War II era, the United States made a deliberate shift from producing mass quantities of weapons towards better quality ones that focused on efficiency; greater accuracy meant risking fewer men and machines to combat losses (Friedman 1998, 34). Today, the drive towards precision warfare is a result of this same public aversion to friendly casualties, as well as the strategic implications of collateral damage and the challenges of urban warfare. When these issues are combined with a technological revolution at the end of the twentieth-century, precision strike capability in war is no longer simply desired, it is expected by the American public and many military planners.

During the last few decades, this movement towards accuracy and precision has been dominated by air-delivered precision-guided munitions (PGMs); however, a similar trend has developed in ground wars fought with indirect and direct fire weapons. While indirect fire systems, such as artillery and mortars, have traditionally been an area attack weapon, these systems are now developing an ability to engage individual point targets on the battlefield. For direct fire weapons that have always targeted individual vehicles and personnel, ground soldiers are experiencing an ability to engage the enemy with a high degree of accuracy that has not been seen before. This technological advantage, coupled with the full spectrum of operations in which the US Army will be engaged, suggests a situation in which the future of ground combat will be dramatically different. The impact of these changes is potentially Army-wide, involving not only soldiers routinely engaged with direct combat (e.g., infantry, armor, and special forces soldiers), but also combat support (CS) and combat service support (CSS) soldiers who carry many of the same weapons.

It appears that the increased accuracy found in current and future direct fire weapon systems will cause a dramatic change in the way the Army trains, organizes its forces, and conducts ground combat in the next ten to fifteen years. This thesis will explore this issue by identifying what is driving the United States Army to possess highly accurate direct fire weapons, as well as analyzing the effects of precision direct fire weapons on the current and future battlefield. This analysis will first look at the evolution of precision weapons in the United States military in order to reveal a trend in the development between Air Force capabilities, Army indirect fires and Army direct fires. Additionally, this thesis will show how aspects of the current and future security environment are instrumental in influencing the Army's transition to highly accurate weapon systems. Finally, current and emerging future technologies for direct fire weapons will be addressed as this thesis outlines the effects of these weapons in terms of the benefits and or limitations they might provide the ground commander.

Background

Recent history has revealed an American "obsession with weaponry in war" that began after World War II and continues today (Friedman 1998, 17). At the height of the Cold War, United States air, naval, and ground forces met a demand for sophisticated weaponry with a supply of advanced systems that used computers, global positioning, improved optics, and lasers to destroy the enemy. The result of these advances was an unprecedented ability to precisely engage enemy personnel and equipment. The most familiar example of this capability has been air-delivered PGMs, now commonplace on the battlefield. Over the last twenty-five years, the world watched the United States Air Force progress from using only a few of these weapons in the 1980s and early 1990s to relying on them as preferred munitions during operations in Afghanistan and Iraq. Specifically, PGM use during Operation Desert Storm consisted of 8.8 percent of all air-delivered bombs and missiles, Operation Allied Force used 35 percent, and during Operation Enduring Freedom (OEF) the total was 72 percent (Lucas 2003, 10-11). This trend continued in the opening days of Operation Iraqi Freedom (OIF) where the use of PGMs remained above 70 percent (Krepinevich 2003, 20). Based on these numbers, the pace at which these systems are developed and applied on the battlefield show no indications of slowing in the near future.

Similar progression towards precision has affected the Army. Richard P. O'Neill, in *War in the Information Age*, states that the development of precision munitions and advanced systems (i.e., links between sensors and weapons) for the Army has resulted in a strike capability that allows for maneuver dominance on the modern battlefield (Pfaltzgraff and Shultz 1997, 182). The Army is currently exploiting these technologies in its indirect fire systems; precision capabilities are now being developed in cannon and rocket artillery as well as infantry mortars. Taking advantage of this new technology does not necessarily require the acquisition of all new weapons; the simple act of adding a global positioning system (GPS) fuse to an existing artillery round provides the ground commander with an organic precision strike capability (Pfaltzgraff and Shultz 1997, 233). For ground units that engage in the "close fight," this demand for highly accurate fires is being met with a supply of precise, direct fire weapons as well. Infantry companies currently possess tube-launched, optical-sighted, wire-guided (TOW) and Javelin missiles--two examples of precision weapons used on the front lines in OEF and OIF. Additionally, infantry and armor units continue to enhance other weapons in their inventory with improved optics and lasers that dramatically improve their accuracy. Slowly, this drive towards improved accuracy may eventually include every weapon in the Army inventory; some will meet the definition of becoming "precision-guided weapons (PGW)" and some will simply allow the operator to drastically improve his ability to hit the target. Major General Scales, former Commandant of the Army War College, has even called for placing a precision weapon "in the hands of every close-combat soldier" (2003, 156). Given this improved capability, which displays little sign of diminishing, the battlefield is changing for ground combat leaders. Army ground maneuver commanders will have to adapt to this improved ability to precisely engage the enemy; lessons learned may be found in the Air Force's experience with PGMs during the last fifteen years and in the artillery community's current development of this new capability. Exploring this issue will provide future ground combat leaders a better understanding of what is happening in today's Army and more significantly, why it is happening and how it will impact the Army's training, organization, and how it fights its future wars.

Assumptions

A key assumption for this thesis is that critical variables in today's security environment do not drastically change over the next ten to fifteen years. This is a bold assumption because many might argue that the one constant in security affairs is change itself. Although the unpredictability of security affairs is acknowledged here, for the purposes of this thesis no significant changes to the current threat environment for the next ten to fifteen years. Specifically, the United States will retain technological overmatch compared to its adversaries during this time period. Another assumption includes factors concerning national will; the American public sentiment will not change significantly towards issues of collateral damage, fratricide, and friendly casualties in war. Although it is possible that a series of catastrophic terrorist attacks on American soil may harden public will, the assumption is valid given the fact that soon after the 11 September 2001 attacks the public retained its traditional concern for casualties during operations in Afghanistan and Iraq. Finally, defense budgets will allow for research and development (R&D) and procurement of improved weapon systems to continue at a rate similar to what the Army has experienced over the last ten to fifteen years. Given the unpredictability of political influences on the Department of Defense (DOD) budget, it is necessary to assume money will always be available to develop the capabilities discussed in this thesis.

Definitions

For the purposes of this thesis, the following terms are defined by the author unless another source is specified.

Accuracy. An accurate weapon is defined as one in which the operator is able to hit what he is aiming at with a probability rate of greater than 50 percent.

Direct Fires. Those fires produced by weapons in which the operator can visually see the target. This ability to see may be enhanced by optics. It is limited to ground-to-ground fires. Given current technologies of vehicular and nonvehicular systems, the range of direct fire weapons extends to approximately 4,000 meters.

Indirect Fires. Those ground-based fires produced by weapons in which the target is beyond the line of sight of the operator or masked by terrain; in either case the operator is dependent upon a separate observer (human or electronic) to see the target.

Maximum Effective Range (Army). The distance from a weapon system at which a 50 percent probability of target hit is expected, or the tracer burnout range (Department of the Army 2004, 1-121).

Precision. A general term to describe the ability to hit a target with accuracy (see above) due to a technological enhancement of a weapon system (i.e., optics, wires, lasers, etc).

Precision-Guided Munitions (PGM). (DOD) A weapon that uses a seeker to detect electromagnetic energy reflected from a target or reference point and, through processing, provides guidance commands to a control system that guides the weapon to the target (Department of Defense 2001, 417).

Precision-Guided Weapon (PGW). Any weapon system that fires a munition that meets the criteria above as a precision-guided munition.

Scope

Research in this thesis will be constrained by what has been documented, in open, nonclassified sources, on accuracy rates of specific weapon systems. The author will be unable to perform or observe tests or simulations of accuracy of the weapons discussed in this thesis. Additionally, the scope of this research will be limited to ground-based, direct fire weapon systems used in United States Army and Marine Corps units. It will not discuss air, naval, or artillery (including mortars) delivered PGMs, except to show evidence that a trend exists in the United States Armed Forces towards an arsenal of highly accurate weapon systems.

Significance of the Study

During the initial research, the author discovered an abundance of information on the impact of PGWs and PGMs on national policy, operational objectives, and tactical level training requirements. However, nearly all of the research has been completed with respect to air and naval PGMs and the author believes a similar study is warranted for Army weapons. Additionally, while infantry and armor units have embraced technological advances in accuracy, the development of tactics, techniques, and procedures (TTPs) to augment these technologies is still in its infancy and many are being formed each day during the Global War on Terror (GWOT). While the United States military continues to take advantage of the current technological revolution, future development of new direct fire weapons and munitions is almost a certainty. As these technologies continue to mature, Army units will have to adapt even further, especially as ground forces continue to be engaged in combat as part of the GWOT. The impact of all this change on the Army's training methodology, force structure and conduct of battle remains unseen and is certainly worthy of exploration.

CHAPTER 2

LITERATURE REVIEW

The literature available on the subject of accuracy and precision fires can be categorized in several areas: a general history of weapons technology as well as an appraisal of their next generation of development; an analysis of air-delivered PGMs and their value in recent engagements; the transformation of conventional, ground-based artillery into precision-capable systems; the current state of direct fire precision ground weapons; and finally, the impact of precise fires in the current security environment. Secondary sources from all these areas will be used to reveal evidence supporting this thesis.

In terms of the technological advances that have been made throughout history, there exists a significant amount of general research on military arms, including both air and ground weapons. This historical review will show a trend in weapons development and the evolution of their capabilities. Specifically, these resources will reveal an American technological evolution that has stressed the importance of not only firepower, but firepower applied with precision across all the services. Much of this history will be relatively recent, beginning at the opening years of the twentieth-century which saw the emergence of repeating rifles, machine guns, and quick firing artillery in World War I (Scales 2003, 17). Focusing on a broad array of technologies and capabilities, these sources include: *An Historical Guide to Arms and Armor* (1991) by Stephen Bull and Tony North and *The Evolution of Weapons and Warfare* (1984) by Colonel Trevor Dupuy. Other secondary sources provide a critical outlook towards the future of weapons development; these publications will be useful in describing where the military is heading in relation to precision fires. A sampling of these works includes: *The Future of War: Power, Technology and American World Dominance in the 21st Century* (1998) by George and Meredith Friedman and *Yellow Smoke: The Future of Land Warfare for America's Military Future* (2003) by Major General Robert H. Scales Jr. These two books, along with a host of professional military journal articles, take a critical look at future warfare and identify the importance of a precision strike capability at all echelons of the current and future force.

Civilian and military writers have produced an abundant amount of literature on the use of PGMs in modern warfare at the strategic, operational, and tactical levels of war. While this thesis will focus mainly at the tactical level, the strategic and operational impacts of PGMs make up a part of this technological evolution that cannot be entirely ignored. The vast majority of this background research focuses on air-delivered PGMs during engagements in the post-Vietnam era including Operation Desert Storm, Operation Allied Freedom, OEF, and OIF campaigns. Again, although this application of fires is outside the purview of this research, many of these writings provide an excellent analysis of the history, benefits, and limitations of PGMs in general. Making the connection between air and ground PGMs, based on similarities in terms of benefits and limitation, will be a key component of this thesis. Examples of literature that will help provide this background include: "Precision Guided Munitions and the New Era of Warfare" (1996) by Richard P. Hallion, "The State of Precision Engagement" (2000) by John A. Tirbak, and "War in the Information Age" (1997) by Robert L. Pfaltzgraff Jr. and Richard H. Shultz Jr. Similar to the Pfaltzgraff and Shultz contribution is a policy article by Robert Killebrew entitled, “Land power and future American defense policy” (1997), which introduces an historical link between weapons evolution a century ago and the impacts of current PGMs on land warfare.

Research on the benefits of ground-delivered PGMs, although not available in as large a quantity as air-delivered PGMs, does exist and mostly in the form of mortars, artillery and missiles. The American artillery community is currently undergoing a precision transformation of its own and PGMs are taking on a significantly larger role in fires employment than anyone probably envisioned when the Copperhead missile first appeared in 1981. Because the military is still developing this new and largely unprecedented indirect fire capability, most of the analysis of these precision munitions will be very recent--with some of the critiques based on experiences in OEF and OIF. Several years ago, John K. Yager and Jeffrey L. Froyland provided an overarching vision of the advances of precision in cannon and rocket artillery in their article, “Improving the Effects of Fires with Precision Munitions” (1997), by outlining three new types of ammunition: “externally guided, self-directing and (or) inertially guided, and target-locating smart munitions” (Yager and Froyland 1997, 5). Three of the most lauded of these developments include the introduction of the XM935 120-millimeter precision-guided mortar munition (PGMM), the XM982 Excalibur 155-millimeter round and the guided multiple launch rocket system (GMLRS) as described in recent military journals. Titles of these sources imply the dramatic shift in the way indirect fires will be used in current and future engagements: “Transformation: Bringing Precision to MLRS Rockets” (2003) by Jeffrey L. Froysland, “Excalibur: Extended-Range Precision for the Army”

(2003) by Danny J. Sprengle and Donald C. DuRant, and “US Army’s New Strategy on Precision Weapons” (2002) by Kim Burger.

While indirect weapon systems continue to develop in terms of accuracy, a similar capabilities-based evolution is growing in ground based antiarmor missiles. This thesis will reveal the impact of these weapons to the extent that they are employed in a direct fire mode, that is, TOW or Javelin missiles. Other examples of improved direct fire accuracy will include smaller arms in the hands of individuals and crews within direct sight of the enemy--these include rifles and guns as well as fire control systems that allow operators to target the enemy with greater precision. Sources on the current and future capabilities of fire accuracy of these guns and rifles are largely found in defense and Army professional journals. A sampling of these sources include: “Through the Chink in the Armor” (2002) by Mark Hewish, “Small Arms Strategy 2000: Infantry School Looks Beyond the Bullet” (1987) by Don Walsh, and “Armor Modernization, the Key to the Future” (1998) by George H. Harmeyer.

Also found in these military journals is an analysis of the training necessary to make these systems accurate. Given any new technology, the implied task for the Army must be to develop a training system as advanced as the weapons they are using--failure to do so would result in an inefficient system, defeating the basic reason for employing accurate weapons in combat. Using the rifle as a prime example due to its proliferation throughout the force, this training requirement will apply across the full spectrum of marksmanship instruction throughout the Army: basic rifle marksmanship (BRM) to new recruits, recertification standards, and the development of advanced techniques that impact more soldiers than just infantrymen. Some of these sources include: “Infantry

Training Today: A Quiet Revolution" (1993) by T. J. O'Malley, "Army Trainers Aim to Sharpen Soldier Marksmanship Skills" (1999) by Joshua A. Kutner, and "Advanced Infantry Marksmanship: Shooting Better Day and Night" by Lieutenant Colonel Michael E. Boatner. Although this thesis will be limited to application within the Army, advances made in other services who share similar weapon systems (e.g., rifles, missiles and mortars) will be noted as appropriate. Sources from these other services include "Stop Drug Boats with Precision Marksmen" (2003) by Lieutenant Mike O'Neill and Lieutenant Commander Chris Robinson from the United States Coast Guard and "A New Page for Combat Marksmanship" (2004) by Charles F. Colleton written for the Marine Corps.

Application of fire within the constraints of the current security environment is a subject that has been written about extensively over the last two decades. These critical sources provide the benefits and criticisms of air-delivered precision weapons. Again, although these weapons and munitions are not the focus of this thesis, these sources will be used to compare and contrast Army precision capabilities with air-delivered PGMs. Key elements of this comparison include issues of collateral damage and issues of maintaining public support in today's complex security environment. Several sources of information on this subject include: "Precision Guided Munitions and Collateral Damage: Does the Law of Armed Conflict Require the Use of Precision Guided Munitions When Conducting Urban Aerial Attacks?" (2003) by Major Edward R. Lucas and "The Impact of Advanced Conventional Weaponry" (1990) by Alex Gliksman.

The above literature discusses in detail the issues associated with precision and accuracy in modern air, naval, and artillery delivery systems. The contribution of this thesis work will hopefully fill a gap that appears to exist in outlining the impact of precision direct fire weapons on the battlefield. While there is a wealth of information pertaining to other delivery systems and munitions, the intent of this thesis is to provide the same critical look at how direct fire accuracy in the Army will impact the military's future. The impact of this capability may not be profound now; however, it will reveal itself in time, much like the changes to airpower that have been made over the last fifteen years and the artillery community is currently experiencing.

CHAPTER 3

RESEARCH DESIGN

The research in this thesis will center on the argument that there is a cause and effect relationship surrounding the growth of precision fires throughout the armed services of the United States. This connection links a demand for greater accuracy in the application of firepower with dramatic changes in the conduct of air and ground combat. The cause of this relationship will be outlined in this thesis by describing the military and societal influences that drive America's armed forces to possess an ability to target its enemy with greater accuracy. These drivers include an aversion to friendly casualties, the minimizing of collateral damage, and the expenditure of less ordnance to achieve a specific, desired effect on the modern battlefield. During this era of technological change that uses microchip technology to gain an unprecedented degree of precision, this demand has been met with a supply of advanced weaponry. Next, the effects of this capability will be discussed in terms of the many training, organizational, and doctrinal changes that are affecting the military now and will continue in the future. The design of this thesis will also follow the assertion that this cause and effect relationship is not entirely new; in fact, this trend has existed, to varying degrees, within the Air Force, the Army's field artillery branch of service and the Army's direct fire units. Using the first two organizations as examples, their experience with precision technology will provide sufficient background to describe in detail how a similar trend in precision targeting is impacting the Army's ground maneuver forces. Although the effects resulting from a move towards greater accuracy will vary among airmen, artillerymen, and riflemen or tankers, the cause of such a change is the same--the pressure to accomplish their mission with the least amount of casualties, damage to civilian areas, and expenditure of resources.

The evolution of weapons outlined in this thesis will provide a short historical background to show the creation of precision weapons over the last thirty-five years. This recent history will reveal evidence that a demand exists for the development of highly accurate weapon systems across all military services, but the greatest potential for growth lies within the Army. Simply stated, American ground forces are next in line to benefit from the technological developments in accuracy that the Air Force has successfully exploited during recent conflicts. As part of this transition from air to ground-based systems, the efforts of the Army's field artillery community cannot be ignored; today's artillerymen are developing new technology to produce a more efficient way of achieving their targeting goals. For infantry and armor units, the change may appear less obvious due to the fact that the rifle, antitank missile and tank main gun are usually considered precise--at least in the modern era of firearms production. Because these weapons' "point of aim" and "point of impact" are measured in extremely small increments, today's systems allow the operator to precisely hit or precisely miss a target based on his ability to aim properly. Given this circumstance, the Army is constantly searching for ways to improve the marksmanship abilities of its soldiers. While historically proven techniques continue to be used, today's soldier is aided with optics, lasers, or microchip driven fire control systems to provide an unprecedented degree of accuracy for rifles, antitank missiles, and tank guns. The examples of air and ground capabilities presented in this thesis will reveal an undisputed trend towards precision throughout the military; this trend exists due to not only technological availability, but because it answers an appeal for greater efficiency from the American people.

Evidence presented throughout this thesis will show how key variables of the current security environment will influence this need for greater accuracy in America's armed forces. The variables used to prove this connection include America's sensitivity to friendly casualties and fratricide, a modern aversion to collateral damage, and the desire to limit the expenditure of munitions while achieving a specific effect on enemy personnel or equipment. Today's military must adapt to these constraints, especially the issue of casualties and collateral damage (a common euphemism for civilian casualties), which frequently dominates worldwide media coverage. This call for fewer casualties and minimal damage, while occurring only a few decades after the massive losses and fire bombings of World War II, is a modern day reality as well as a critical planning consideration for military leaders. Additionally, commanders at all levels are affected by these limitations in an environment where the actions of individual soldiers have the potential to influence national will and thwart national policy.

After this thesis sufficiently establishes that there exists a need for increased weapons accuracy for soldiers and that the Army has already begun developing this technology, the next logical step will be to answer the question of what effect this capability will have on the future of ground combat. For the Air Force and field artillery, there has been a dramatic effect in the way airmen and artillerymen train for and prosecute warfare based on the availability of precision weaponry. While air assets have had greater opportunity to change their style of warfare due to an earlier proliferation of these systems, the impact of precision on artillery remains largely unseen as many of its precision capabilities are still in development. Among the Army's maneuver forces, greater accuracy will impact how units form, equip, train, and employ a new array of targeting capabilities on a battlefield that is expanding due to the technological advances in weapons ranges and lethality.

Across all the services, the most immediate effect of this need for precision will be the procurement of newer, smarter weapons. As these weapons are developed and used in combat, the organizational, doctrinal, and training impacts of this drive towards accuracy will directly affect those service members who use the new systems; however, many of these impacts will hardly be noticed because many will perceive them as mere evolutionary changes. Using the experiences of the Air Force and field artillery as a backdrop, chapter 4 of this thesis will reveal the evolutionary and potentially revolutionary impacts of precision technology on infantry and armor units, many occurring today and several projected for the future.

CHAPTER 4

WEAPONS ACCURACY AND DIRECT FIRE WEAPONS

> In the same way that the primitive guns of the conquistadores revolutionized warfare for five hundred years following their introduction, the still primitive precision-guided munitions – from giant cruise missiles to tiny antitank rounds – will revolutionize warfare in the coming epoch. Nothing will be the same again. (1998, 16)
>
> George and Meredith Friedman, *The Future of War*

Introduction

A United States Army soldier engages personnel and vehicles in combat by centering his target in the sights of his weapon and pulling the trigger. While his "point of aim" may not match the "point of impact" of the round due to wind, trajectory of the round, target movement, or poor weapon handling during activation of the trigger, the mechanics remain fairly simple. Simple actions during wartime, however, can become exceptionally complex and difficult when a myriad of distracters can cause a soldier to miss his target--resulting in a staggering number of "misses" compared to "hits" during combat. The results of such inefficiency in targeting include an increase in friendly casualties, collateral damage, and the expenditure of valuable ammunition. These issues have led the Army to develop systems to assist the average gunner in improving his ability to minimize the difference between his "point of aim" and "point of impact." These developments include various optics, lasers, and fire-control systems that meet the demand for better accuracy on the battlefield. In *The Future of War*, analysts George and Meredith Friedman state that these developments make up a modern revolution of arms, one that began during the Vietnam era and continues today (1998, 16). This chapter will describe the causes and effects of accuracy in direct fire weapons while showing how such a development is consistent with a service-wide trend towards precision.

Precision and the Air Force

Although the United States Air Force is a relatively new organization with weapons platforms less than a century old, it has led the way in precision warfare. The editor of *Aerospace Power Journal*, Lieutenant Colonel Eric Ash, describes precision as "a bedrock of aerospace power" upon which the Air Force has always relied (2001, 3). In his editorial entitled "Precision Doctrine," Ash points to Air Force history to show that concerns over accuracy drove the equipment and organization of the Army Air Corps leading up to World War II with the goal of daylight precision bombing (2001, 3). Interestingly, it was during World War II that the development of air-delivered PGMs began. While this war is remembered for its large-scale air attacks using conventional bombs, by the end of the war the United States, as well as Germany, was capable of targeting key infrastructure with bombs and missiles controlled by radio, radar, and television guidance systems (Hallion 1996, 9). The evolution of accuracy for air-delivered bombs cannot be argued; depicted in table 1 are the Circular Error Probable (CEP) measurements from World War II to Vietnam.

Table 1. Air-Delivered Accuracy

War	Number of Bombs	Number of Aircraft	CEP (in feet)
WW-2	9,070	3,024	3,300
Korea	1,100	550	1,000
Vietnam	176	44	400

Source: Hallion 1996, 7.

While the Air Force was able to achieve a CEP of 400 feet in Indochina, it was still using conventional munitions for most of the conflict; by the end of the war that would change. Setting off what Major General Scales refers to as the "indirect fire precision revolution," American airmen became equipped with laser-guided munitions that allowed them to target bridges in North Vietnam within one meter of accuracy (1995, 238). This evolution of accuracy continued throughout the remainder of the century and was perhaps best demonstrated with video images of PGMs entering windows and chimneys of targeted buildings during the 1990-1991 Gulf War. According to the Gulf War Air Power Survey:

> Against point targets, laser-guided bombs offered distinct advantages over "dumb" bombs. The most obvious was that the guided bombs could correct for ballistic and release errors in flight. Explosive loads could also be more accurately tailored for the target, since the planner could assume most bombs would strike in the place and manner expected. Unlike "dumb" bombs, LGBs [Laser Guided Bombs] released from medium to high altitude were highly accurate. . . . DESERT STORM reconfirmed that LGBs possessed a near single-bomb target-destruction capability, an unprecedented if not revolutionary development in aerial warfare. (Hallion 1996, 11)

As the desire to more effectively target the enemy drove the Air Force to enhance its precision capability, also influential were issues that helped define the security environment, predominantly national will.

While the end of the Vietnam War witnessed the advent of sophisticated air-delivered PGMs, it also stood as an example of how maintaining the support of the American people was critical to keeping a military presence overseas. Some of the ways the military is able to sustain the will of the public is by minimizing friendly casualties as well as preventing collateral damage. Lieutenant General Glosson points to this issue of casualty sensitivity in his article, "Impact of Precision Weapons on Air Combat Operations," by making a direct correlation between American values and the need for air-delivered PGMs (1993, 7). Lieutenant Colonel Ash agrees; the issues of values and morality are fundamental to the demand for PGMs as a “political necessity” (2001, 3). While some may interpret the morality issue as a purely American concern, it is one shared by several nations today. One example of this broad concern for casualties was seen during Operation Allied Force in Kosovo where the mission itself was made possible by the existence of PGMs and their assurance that only military targets would be destroyed in the air campaign (Tirpak 2000, 25). What began as an Army Air Corps reluctance to avoid damaging civilian centers during World War II had now developed into a basic planning requirement to avoid collateral damage as well as protect American airmen (Pfaltzgraff and Shultz 1997, 180). Because the very nature of a precision weapon implies first strike success, the need to conduct multiple passes over a single target is minimized; such an advantage must surely be welcomed by airmen who must accept the risk of flying those subsequent missions (Hallion 1996, 8). Following the same logic, it is most likely that the airmen’s family, community, and their country would be more receptive to the mission, operation, and perhaps even a war in which this technological overmatch was demonstrated.

If this need for air-delivered PGMs has been facilitated by advances in technology and public support, what of the effects? Richard Hallion states in his article, “Precision Guided Munitions and the New Era of Warfare,” that PGMs will have to continue to adapt with changes in technology; the development of micro-munitions, hypersonic missiles, thermoflux weapons, and stealth capabilities for PGMs will be a military necessity to retain a technological edge (1996, 15). This edge is critical to maintaining the current technological overmatch that allows the American military to plan and execute missions with great success. Tactically, the impact of precision when planning these missions is “staggering” according to one analyst; sortie and munition planning factors have changed dramatically now that one or two PGMs can do what was previously required of 1,000 bombs (Cobleigh 1987, 50). Looking at this organizational impact from a historical perspective, Lieutenant General Glosson claims that the Schweinfurt raid of World War II, which required endangering 3,000 airmen, would only require the resources of two pilots today (1993, 5). This comparison shows the “PGM effect” on not only organizations and air planning but the dramatic impact on force protection as well.

Precision and Ground-Based, Indirect Fire

Precision weapons and the cause and effect relationship that helps define them are becoming well represented among the Army’s indirect fire systems. As artillery and mortar systems develop their PGM capability for many of the same reasons as Air Force systems, the future impact of this change will remain largely theoretical until more of these munitions are developed and employed in combat. Nonetheless, as one looks at recent operations in OEF and OIF, it would be difficult to miss the call for greater precision in fire support as well as the impact such expectations will have on tomorrow’s artillery and mortar units.

The technological evolution of artillery fires has been developing for much longer than airpower assets; however, the concept of precision is a much newer one. Regardless of the timing, the objective remains the same: “a first round hit . . . the goal of the US Field Artillery” (Yager and Froysland 1997, 5). The artillery’s first smart weapon, Copperhead, was fielded in 1981, yet it yielded only a 70 percent target-hit success rate at the National Training Center in Fort Irwin, California (Yager and Froysland 1997, 5).

With Copperhead in its arsenal, the Army continued to rely heavily on its conventional cannon and rocket artillery throughout the 1980s and 1990s; however, one of the drawbacks to these weapons was a loss of accuracy as the range-to-target distance increased (Gourley 2001, 56). This issue of range and accuracy led the Army to upgrade its primary multiple-launch rocket system (MLRS) after operations in Desert Storm. While an interim system helped extend range, but not accuracy, the solution became a GMLRS system that possessed the ability to extend firing capabilities to an unprecedented 70 kilometers without a loss of accuracy (Froysland 2003, 17). For cannon artillery, the current development is the XM982 Excalibur, scheduled for fielding to the Marine Corps in fiscal year 2005 and Army in fiscal year 2006; this 155-millimeter round will be equipped with both GPS and an inertial measurement unit (IMU), yielding a CEP of 10-meters (Sprengle and DuRant 2003, 13). Finally, Army developers plan to provide infantry and armor units with their own organic indirect fire system in the form of the 120-millimeter PGMM. The initial version of the PGMM will be able to range to 7.2 kilometers and have the ability to target enemy personnel behind rudimentary cover as well as stationary, lightly armored vehicles on the future battlefield (Herrick 2002, 28).

Given this impressive array of new systems, it appears that the Army is following in the footsteps of the Air Force in its weapons development priorities. Aside from technology, what else is driving this development? Given the similarities of the systems, it should not be surprising that many of the variables of the current security environment affecting the Air Force would also influence the Army. As with the Air Force, the issue of collateral damage and civilian casualties are at the forefront of the need for PGMs in ground-based fire support (Yager and Froysland 1997, 5). In order to meet this need, munitions, such as the Excalibur, have multiple fail-safe systems in case the GPS signal is lost, preventing detonation and automatically re-directing the round to a pre-programmed safe area in which to land (Sprengle and DuRant 2003, 15). This concern for casualties has affected rocket use as well; fear of collateral damage in Bosnia and Kosovo prevented the employment of MLRS rockets and subsequently drove the development of the GMLRS for greater accuracy (Froysland 2003, 18). The issue of collateral damage is increasingly important when operations are conducted in an urban environment, as they frequently are today. Excalibur’s unitary round meets this demand by providing the ground commander with the option of a point-detonation or air burst capability depending on the concerns of collateral damage (Sprengle and DuRant 2003, 14). The challenge of preventing collateral damage is a significant driving factor for the development of the PGMM according to Jane’s 2004 World Armies procurement analysis (“United States Procurement Detail” 2004).

Although preventing collateral damage is important, especially in urban operations, the tactical necessity of responsive indirect fires remains a top priority for ground commanders who value the safety of their ground forces engaged in the close fight. General Glenn K. Otis points out, “The fundamental tenet of [precision strike] is that we not expose our forces to enemy fires any more than we have to” (Antal 1998, 42). This statement may seem overly simple; however, it is one of the driving forces behind the employment of PGMs in close combat. Lieutenant Colonel John Antal, in his article “Future of Maneuver,” describes this type of protection as “high-tech distant punishment” by placing more emphasis on firepower and less on the requirements to place soldiers in harm’s way (1998, 42). Accomplishing this lethal effect requires a very small element (i.e., two personnel) to act a forward observer for either air or artillery delivered PGMs. Ideally, there would not be any risk to human life and artificial sensors could potentially serve as the target acquisition element; however, close combat is not a risk free endeavor--a fact that soldiers of the Army and Air Force understand extremely well. When asked about fire support on the modern battlefield, Major General Hagenback, ground force commander during Operation Anaconda in OEF, stated, “ideally you want precision, but it really boils down to wanting responsive, effective fires” (McElroy 2002, 8). In the interview, Major General Hagenback described his reliance on air-delivered precision fires during the battle while at the same time expressing a need for organic, accurate artillery, which was limited in OEF. It appears that given the advances in precision artillery strike capability, Hagenback and other future ground commanders will soon be able to have the best of both worlds.

The impact on precision weapons in the field artillery community remains to be seen given that the vast majority of weapon systems still under development; nevertheless, there appear to be significant organizational and doctrinal changes afoot. One recent impact, representative of this move towards precision, was the 2002 cancellation of the Crusader artillery system (Burger 2002, 10). The cancellation resulted in a re-allocation of future spending dollars, prompting Major General William Bond, director of force development, to state, “There is little money in this [five-year spending plan] for other than precision” (Burger 2002, 10). While force development continues to focus on precision, artillerymen will focus on target location. Due to the characteristics of a PGM, a precision munition is only as accurate as the target data provided; Major General Maples, Chief of Field Artillery, highlighted this concern in his “2002 State of the Field Artillery" where he stated the artillery must improve its target acquisition skills in support of precision fires (2002, 6). These training implications are similar to what Major General Hagenback called for in his Operation Anaconda interview with *Field Artillery* magazine:

> We have a huge procedural and training issue we've got to work through with our Air Force friend. . . . [N]ot even the battalion commander could call in precision-guided munitions. What happens if the ETAC is injured and has to be MEDEVACed or is killed? We need training and certification of our observers to call in JDAMS – any precision munitions or air support – to be universal observers, if you will. Our Field Artillery leaders, both in the 10th and the 101st Division, knew this would be an issue and worked hard to try to get their observers certified. (McElroy 2002, 9)

It is clear from this statement that the training requirements for artillerymen will only become more challenging in the future due to the proliferation of PGMs on the battlefield. While much of the artillerymen's current challenges with precision stems from supporting Air Force munitions, it seems logical that similar concerns will surface as precision 120-millimeter and 155-millimeter rounds begin impacting in the close fight.

Using both the Air Force and field artillery as exemplars, this brief overview implies a complex arrangement of weapon systems, organization, training, and doctrine that impact the way airmen and artillerymen will continue to fight future engagements. Next, a more in-depth analysis will show that precision weapons are increasing within Army direct fire units as well, and for many of the same reasons that affected the Air Force and Army indirect fire elements. Most importantly, this capability will have effects on how future combat operations are conducted--effects which may or may not be desired by tactical leaders.

Precision and Direct Fire

> Maneuver forces must be provided with the tools to adequately support an offensive strategy dominated by precision firepower on a distributed battlefield. To do this, ground forces at the lowest tactical level must be given the same relative advantage in precision firepower as that possessed by the air services today. (2003, 155)
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> Major General Scales, *Yellow Smoke: The Future of Land Warfare for America's Military*

This section will analyze the development of accuracy in several Army weapon systems that contribute to the close fight by engaging the enemy with infantry and armor forces. The rifle, tank gun, and antitank missile, while forming the basics of ground warfare in the twentieth-century, look and perform very differently today than they did when they were first introduced to the battlefield. While these weapons perform the same basic function for which they were created, their effectiveness has changed dramatically due to the development of a precision capability in each of these systems. The key to achieving precision effects is found in the term "system;" today's weapons possess advanced acquisition and targeting capabilities that early developers probably never dreamt possible. Midway through the twentieth-century, rifle and gun models were exceptionally simple in their mechanics and the operator was forced to bear the full responsibility in locating and engaging his target. Today, the growth industry of information warfare is complementing the organic capabilities of these arms by providing an unprecedented ability to locate, track, and destroy a target. The benefits of these highly accurate targeting systems are not limited to simply improving a soldier's efficiency in defeating his enemy; improved force protection and limited collateral damage are other positive byproducts of these advanced systems--meeting the demands of a concerned public that continues to influence the deployment of forces and their weapons into battle.

Direct Fire: Antitank Guided Missiles

Although the antitank-guided missile (ATGM) is the most recently developed ground weapon discussed in this analysis, its introduction to the battlefield was designed to answer a decades-old problem of how best to defeat the seemingly all-powerful tank. Due to the ATGM's advantages in range and accuracy, "there was strong body of opinion in the early 1970s asserting that the missile had sounded the death knell of the tank" according to Charles Messenger in his book on antitank history (1985, 17). Although the tank certainly did not fall to such depths during that decade, the ATGM's potential for a "sure-kill capability" was imagined by Professor Christopher Gabel in his study of antitank technology during and after World War II (1985, 70). This assessment appeared to be validated by the apparent antitank successes of American TOW missiles fired from helicopters in Vietnam and the use of SAGGER missiles against Israeli tanks in the 1973 Arab-Israeli War (Messenger 1985, 17). Major General Scales refers to the early successes of TOW and SAGGER ATGMs as part of a "precision revolution" due to the effectiveness of these missiles in the 1970s (1995, 238). The dramatic technological change contributing to this revolution was the guided nature of ATGMs; this enhancement provided modern antitank gunners a significant capability over World War II-era tank destroyers that lacked a target acquisition capability for the gunner. While the improvement was dramatic, evolutionary steps were necessary to make the system efficient. The first generation of these ATGMs allowed the gunner to steer the wire-guided missile onto the target using a joystick; however, the system was also dependent upon the gunner's ability to control the missile under fire (Messenger 1985, 17). This targeting system required the gunner to maintain two simultaneous sight pictures--one on the missile and one on the target, a challenging feat while surrounded by combat conditions. The second generation ATGMs improved due to a fire control system known as SACLOS (semiautomatic command to line of sight) which allowed the operator to simply maintain a line of sight on the enemy tank and the missile would follow that line onto the target (Messenger 1985, 17). The United States Army's TOW missile system uses this same technology and has allowed antitank gunners a precise targeting capability for over three decades.

While the TOW missile system saw its first action in Vietnam aboard an airborne platform, its contribution to the close fight when fired from multiple ground platforms is also well documented. Over the years, the TOW, the infantryman's first PGW, made improvements to its engagement range, acquisition system, and lethality capabilities in order to remain current and adaptive. According to the TOW2A/B (most current model) project manager, Colonel Lloyd McDaniels, the TOW was used successfully in OIF as "a precision assault weapon to take out various types of targets, not just tanks, which it did, and it did very well, but it also took out buildings, attacked strongholds . . . artillery emplacements and things like that" (Roosevelt 2004). An example of this antistructure capability was the TOW's participation in the assault on a building in Iraq housing Saddam Hussein's two sons during OIF (Tyson 2003). According to a report in *The Christian Science Monitor*, when special operations forces were unable to breach the reinforced walls of the building, they pulled back and utilized TOW missiles from the 101st Airborne Division (Air Assault) to destroy part of the structure (Tyson 2003).

Using the TOW in this manner takes advantage of its inherent precision and lethality while allowing friendly forces to place themselves outside effective direct fire range from the enemy.

The issue of stand-off range (the difference between the effective ranges of two opposing systems) is critical to the value of the TOW missile system because stand-off equates to force protection for the gunner. Stand-off range was most likely the TOW's greatest attribute in the 1980s and 1990s--with a maximum effective range of 3,750meters, it could defeat enemy armor from outside the opposition's weapons ranges. However, as the ranges for opposing armor increase, so must the range of the ATGM. The TOW missile appears to be meeting this standard by increasing its range from 3,750 meters to a projected 4,500 meter range with the TOW 2B Aero variant (Roosevelt 2004). The Army has also pursued the critical capability of achieving the same stand-off advantage at night. The TOW's new ITAS (Improved Target Acquisition System) night sight allows gunners to double their acquisition range of enemy armor during limited visibility with the use of a second generation FLIR (Forward Looking Infrared System) capability (Gourley 2000, 63). Since many main battle tanks have a maximum effective range of only 2,000 meters, the TOW must be able range beyond that figure at night; with the ITAS thermal sight, the twenty-first century TOW can do just that (Gourley 2000, 63). During OIF, the 101st Airborne Division (Air Assault) employed the ITAS sight successfully in combat; it performed so well that the division commander referred to it as the hero of the battlefield (Roosevelt 2004). The TOW's lethality and ability to protect the force are not the only metrics used to evaluate the effectiveness of a weapon--the issue of collateral damage must also be considered in today's complex security environment.

As a PGW, the TOW must meet extremely high standards of employment when fired on the battlefield. These expectations are certainly justified when one considers the concerns over collateral damage and fratricide that have tempered offensive action over the last few decades. In 1993, as United States forces supported United Nations peace operations in Somalia, the Army had to react to reports of several Cobra gunship-mounted TOW 2A projectile missing their targets and producing far worse effects on the civilian populace (Fineman 1993). During several missions, errant missiles killed a Somali aid worker, a woman, and a child, reportedly "spreading panic and fear throughout [the] capital" (Fineman 1993). In an effort to prevent misidentification of targets, including other friendly forces, the new TOW ITAS provides the vehicle commander a video image feed of the target (Tripp and Clark 2001). Past TOW systems only allowed the gunner the ability to see what he was aiming at; this new extra-man-in-the-loop capability doubles the number of eyes confirming the legitimacy of a target before the trigger is pulled. There is little doubt that the development of this advanced technology is a reaction to public pressures of accuracy; these expectations can be summed up by a United Nations official who stated, "I'm not impressed if we fire 1,000 missiles and only one fails. If it kills a woman or a child, we lose the battle that day" (Fineman 1993).

The prospect of 100 percent accuracy is highly unlikely, especially with human error factored into the system; nevertheless, today's TOW continues to exploit modern technology in order to maintain the highest degree of accuracy on the current battlefield.

In addition to the second generation FLIR thermal sighting and commander's video feed, today's TOW system also possesses an unprecedented counter-countermeasure capability that prevents the missile from reacting to invalid signals or acquiring false targets (Gourley 2000, 62). The system's upgraded boresighting capability limits the amount of time and human error involved in adjusting its optics for environmental changes; the new TOW ITAS does this automatically, ensuring a greater "hit probability" than ever before Gourley 2000, 62). Other technical advances include an "aided target tracker" that automatically directs the missile towards the center mass of the target upon firing as well as a sub-system to approximate target range based on the gunner's sight picture (Langhauser 20002, 15). Finally, TOW's manufacturer, Raytheon Corporation, has announced perhaps its most dramatic advance yet for the wire-guided system--the plan to replace the guidance wires with a data link subsystem that will direct the missile onto the target ("TOW 2A/2B Goes 'Wireless' for the Army's Future Force" 2004, 17). Currently, the Army has yet to commit to this enhancement; however, the rationale for "wireless" and other technological upgrades remains the same: to minimize system limitations and human error in order to produce an increasingly precise ATGM that will keep soldiers and noncombatants safe on the twenty-first century battlefield.

Although the TOW's ability to go "wireless" is a recent development, the force protection advantage of this technology is not new to the Army's ATGM arsenal thanks to the invention of the Javelin antitank missile in the 1990s. Its fielding was lauded in a message from the Army's Chief of Infantry, Major General Ernst, who stated in 1996, "the U.S. Infantryman now has at his disposal a man-portable antitank missile system that offers unsurpassed accuracy, reliability, lethality, and survivability" (1996). The assurance of reliability gave infantrymen confidence that the Javelin would perform better than the defunct Dragon ATGM and the promise of lethality implied a one shot, one kill capability that soldiers expect from their weapons. While the presumption of reliability and lethality proved true for the Javelin, accuracy and survivability became revolutionary capabilities that future infantrymen would experience once the weapon was employed in battle during OIF.

The accuracy and performance of the Javelin has undergone numerous tests, spanning several years, from practice maneuvers at the National Training Center (NTC) to the battle “lab” in Iraq. *Jane’s Defence Weekly* reported early trials revealed a 92 percent first round hit probability and although the missile could travel 3,500 meters, the maximum effective range is published as 2,500 meters (Foss 2002, 38). At the NTC, the Javelin has been credited with highly impressive performances. According to Major McDonald, a weapon system manager evaluating the missile’s capabilities, one exercise at the training center witnessed a Javelin-equipped infantry company destroy sixty opposing vehicles while experiencing minimal friendly casualties (1998, 4). While some may challenge McDonald’s claim that the Javelin’s impact is comparable to that of the machinegun, the weapon does provide light infantry forces a man-portable antitank capability that has never previously been seen (1998, 4). Perhaps the best authorities on the subject are the enlisted personnel directly responsible for the employment of the Javelin; according to Sergeant Hyder, an antitank section leader training at the NTC:

> Its obvious what it does, there are twenty, maybe twenty five vehicles…dead. A single soldier with something on his shoulder that can take out a $3 million tank and its crew. . . . [Y]ou’ve got something. In the old days, with the Dragon [antitank system], we’d have been lucky to get one or two. Now we have a system

> at company level that can save lives by bringing attrition of the enemy down to a certain level, reducing the casualties on the company. (Steele 1997)

As SGT Hyder describes the performance of the Army's new lightweight antitank weapon, it is easy to understand how its accuracy and the issue of force protection are intertwined.

In 1990, the subject of force protection for light forces became a contentious one during Operation Desert Shield. In response to Iraq's invasion of Kuwait, the United States Army deployed the 82nd Airborne Division to Saudi Arabia; facing a significant armor threat, dismounted soldiers of the division were forced to assume a great deal of risk against Iraqi armor (McDonald 1998, 5). While TOWs would be used to protect the force from armor attacks at long range, the Army's short range antitank options were limited to the poor-performing Dragon. Today, it appears that this risk has been sufficiently mitigated with the Javelin. One clear example of its force protection capabilities was reported by Thom Shanker in the *New York Times* article entitled "How Green Berets Beat the Odds at an Iraq Alamo." The article describes how a lightly equipped American unit successfully defended itself against an armor threat consisting of four tanks and six armored personnel carriers (*New York Times*, 22 September 2003). During the engagement, two soldiers (Sergeants Adamec and Brown) destroyed several vehicles with their Javelin missiles and were recognized for turning the attack into "chaos" (*New York Times*, 22 September 2003). According to their commander, "Two guys shut down the attack. . . . They halted an entire motorized rifle company" (*New York Times*, 22 September 2003). The purpose of these anecdotes is not to imply the Javelin is a panacea to armor warfare; instead, the war stories show the overmatch capabilities that this system provides to the American soldier.

The force protection advantage of the Javelin stems from several technological advances. First, and most significant, is the "fire and forget" capability of the missile system--this allows the gunner to displace to a protected position immediately after firing the weapon. Second, the "soft launch" capability allows the gunner to fire the missile from a protective fortification, such as inside a room or covered fighting position (Gourely 1996, 60). Finally, the smoke signature of the missile, once deployed, is significantly minimized, limiting the enemy's ability to identify the missile's point of origin. The purpose of these advances, previously lacking in the Dragon system, is the survivability of the gunner. The proven advantages of accuracy, range, and force protection make the Javelin an extremely popular weapon; the result of which is an impact on combat organizations as the Army tries to meet the demand of commanders who want these weapons in their units.

The impact of the advanced TOW and Javelin ATGMs on the modern Army has been widespread. At the start of the twenty-first century, as the United States Army began to transform its ground maneuver force into a more modular configuration, the precision capabilities of the TOW and Javelin were found in the equipment lists of every maneuver battalion. According to the 2004 *Army Comprehensive Guide to Modularity*, TOW missiles will be found in the Army's new Combined Arms Battalions (combined infantry and armor companies) and Javelins will support these same battalions as well as Infantry Battalions and Battlefield Surveillance Battalions. These three battalions make up the bulk of the Army's brigade structures, identified as either Heavy Brigade Combat Teams (HBCT) or Infantry Brigade Combat Teams (IBCT). The HBCT and IBCT are the Army's newest brigade sized units for land warfare and will deploy with the 3rd Infantry

Division and 101st Airborne Division (Air Assault) in support of OIF in 2005. These brigades join the wheeled Stryker Brigade, who already has been battle tested in two OIF rotations, as the three modular Brigade Combat Teams that can be used for maneuver and close combat (US Army Training and Doctrine Command 2004, 5-2). The Stryker Brigade, whose formation in 2000 can be credited with starting the Army's transformation process, includes TOW's at the Brigade level and Javelins in all combat battalions. Perhaps the most significant change for antitank capabilities is the proliferation of Javelins throughout the Stryker Brigade--amounting to a Javelin gunner assigned to every infantry squad (Department of the Army 2002, 1-12).

While one impact of the ATGM's success has been organizational, other tactical and doctrinal considerations will almost certainly have to be made to support the weapon's capabilities. The issue seemed apparent to Marine Corps Captain Hatala whose article entitled, "We're not Ready for the Javelin," argued that unless doctrinal changes are made, the effectiveness of the Javelin will be stymied. (1999, 75). Stating that "tactics must be adjusted," Hatala points to the Javelin's top-down attack capability over the Dragon, in addition to the other advantages identified in this thesis, that directly relate to changes in how to effectively employ the weapon (1999, 75). At the very least, according to Captain Hatala, military planners "should not underestimate the impact that [wireless technology] alone will have on the future of antiarmor warfare" (1999, 74). Major McDonald agrees that the modern ATGMs are changing the look of the battlefield--"Due to the Javelin's extended range capability, battalion frontages have grown to 16 kilometers wide and six to eight kilometers deep" (1998, 4). These dimensions will almost certainly continue to increase if the Javelin's future P^3I program is successful in increasing the weapon's range from 2,500 meters to 4,000 meters (Hewish 2002, 40). The combination of this survivability and the sniper-like accuracy of a greater-than-90 percent success rate may simply be seen by historians as an evolutionary development in ATGMs; however, for soldiers on the ground, like Sergeants Hyder, Adamec, and Brown, the capabilities of the Javelin probably seem very revolutionary from their fighting position. Regardless of the classification, it is apparent that both TOW's and Javelins continue to make a significant impact on the battlefield.

In summary, as the Army continues to equip all of its armored battalions with TOW missiles and the Javelin is acquired by even more units, enemy armor formations will have to adapt to an American enhanced precision attack threat. This problem is compounded by the fact that the ATGM rarely stands alone on the battlefield; typically an adversary is more concerned with the lethality of modern main battle tanks. While the destructive capability of the tank has improved due to improved munitions, it is the M1 Abram's fire-control system that is the basis for the vehicle's true destructive power.

Direct Fire: Tank

The ATGM developed its initial precision capabilities during the same era that the world witnessed a similar change in armor firepower. World War II revealed the unmatched maneuverability of tanks, especially when combined with other arms, but an inherent ability to shoot its main gun with great accuracy would wait another twenty years. Major General Scales, in his book *Firepower in Limited war*, recognized the precision potential of the tank when he declared the presence of a "precision revolution" that also included the tank's nemesis, the ATGM (1998, 238). An example of these dramatic changes in capabilities came during the 1973 Arab-Israeli war when tanks required only two rounds to destroy an opposing tank, compared to seventeen rounds needed twenty years earlier during World War II (Scales 1998, 238). While hit probabilities increased, so did effective ranges--nearly tripling during this time period; Major General Scales credits this revolutionary change to range finders, ballistic computers, and improved ammunition (1998, 238). This section of the thesis will show how these technological advances continue to develop a precise firing capability in today's armored vehicles. The basis for this analysis will be America's M1 Abrams tank, which has proven its unmatched capability on the battlefield in Kuwait and Iraq over the last two decades. It is important to note that the M1 Abrams is not the only tank possessing the many technological advances identified in this thesis; many nations, mostly American allies, have some comparable technology. While America may not possess outright tank-tank overmatch against every nation, it does not appear that any of America's potential foes can meet the same high standards in accuracy based on a combination of technology, training, and tactics.

Technology, training, and tactics are reliant upon each other. Just as tactics must maintain pace with technology, technology must be able to support a desired change in tactical or operational doctrine. Training makes this relationship efficient. If all three components are present, an army will have a modern, well-trained force ready to execute sound doctrine whenever its nation calls. The United States Army has such a combination in the M1 Abrams tank and the crewmen that man it. While American tankers pride themselves on technical and tactical competence, the vehicle is well known for its protection, mobility, and lethality. It is this last trait that will be discussed here, specifically in terms of the M1 Abram's fire-control system that allows the tank to precisely target and destroy another vehicle while on the move and under conditions of limited visibility.

Analyzing the brief history of European, American, and Russian tanks during the Cold War reveals a gap in the quality of fire-control systems when they met in the 1991 Gulf War. According to James Dunnigan in his book *Digital Soldiers*, this gap in fire-control systems began in World War II, but the Soviets attempted to compensate for it with larger number of tanks (1996, 66). George and Meredith Friedman, in their analysis of warfare's future, state that the United States chose not to follow the same strategy of mass; instead, "tank production concentrated on improved fire-control systems designed to increase the percentage of hits and kills on enemy tanks rather than concentrating on increasing the number of tanks" (1998, 34). Friedmans' evaluation is similar to that of Major General Scales: the dramatic changes in fire-control systems aboard armor platforms revealed the start of a technical revolution that included range and precision (1998, 34). When the technological gap did not close during the Cold War, the result was an overwhelming defeat of Iraq due to Western capabilities: computerization, laser range finders, weather sensors, and stabilized platforms for a shoot-on-the-move capability (Dunnigan 1996, 67). Leading the way in this armor victory was the M1 Abrams tank. Twelve years later, the two armies met again in battle; while the Iraqi army fought with the same T-72s, the United States Army was armed with a tank equipped with twelve years of upgrades.

"Abrams tank lethality is already unmatched"--this statement was made proudly by the head of the Army's Armor Center, Major General Terry Tucker, in his bimonthly address to all tankers in *Armor* (2004, 4). While effective ammunition certainly plays a role in this lethality, the hardware and software allowing the round to penetrate belongs to the Abram's main gun and fire-control system. The M256 main gun is a "precision, direct fire weapon where accuracy is of the utmost importance" according to Army Research Laboratory (ARL) responsible for the gun's development (Morgan-Brown 2003). The goal of the ARL, published in its March 2003 electronic newsletter, is "one shot, one kill" directed at a target as small as one meter square over a mile away (Morgan-Brown 2003). While one lab strives to build the most accurate tank possible, soldiers continue to test the systems in field laboratories from the NTC to Iraq. During the Army's 2001 Division Capstone Exercise (DCX) at the NTC, the Army tested its latest M1A2 upgrade--system enhancement program (SEP). The M1A2 SEP performed up to par, allowing gunners the ability to "kill" moving enemy armor at 3,400 meters, dramatically increasing the effective range of the Abram's gun system (Steele 2001). In March, 2003 the Army and Marines, alongside coalition partners, attacked into Iraq; although operating without the newest SEP upgrades, the Abrams once again proved its worth. One Marine tank battalion reported destruction of over eighty Iraqi tanks without any friendly losses ("The Latest Word on Trends and Developments in Aerospace and Defense" 2003). Results such as this leave little room for doubt that the tests conducted in real battle labs were a major success.

In preparation for a 2005 rotation to OIF, 4th Infantry Division tanks will receive the SEP upgrade which performed so well at the DCX four years ago (Tucker 2004, 4). SEP provides extensive target acquisition improvements with new infrared optics that allow the tank crew to clearly identify a target over 8,000 meters away (Loeb 2003). This capability, which provides the tanker a fifty power zoom to see this extended range, is critical to today's complex battlefield mixed with enemy and civilian vehicles (Loeb 2003). Tanks commanders have the option of destroying the target itself, at a new effective range of 4,000 meters, or using its laser designator to pinpoint the target out to 8,000 meters away for destruction by artillery or aerially delivered PGMs (Loeb 2003). This combination of units supports the military's desire to enforce more combined arms and joint participation in order to maximize the effects of its technology. The improvements have also been applied to the infantry M2A3 Bradley fighting vehicle; Lieutenant Colonel Ricardo Riera sums up the new targeting capability for his battalion at the DCX:

> Before on a basic Bradley, I would have to go and I would have to use my sight to see something at about 4,000 to 5,000 meters, then I would have to use my map, and my compass or my PLGR (Precision Lightweight GPS Receiver). . . . Now I go in there, and I sit in my Bradley, and I have 48x power field of view, so I can see very, very far out. I can see in excess of 10,000 meters. Now I can lase and get a 10-digit grid. What that does is that means I can call for fire and destroy things with artillery that before I had to destroy with direct fire, or perhaps guess at the precision fire for artillery. ("Exercise Showing Power of Digitization, Army Officials Say" 2001)

Support for his direct fire engagements, according to Lieutenant Colonel Riera, comes directly from the second generation FLIR, found on both the new Bradley and Abrams, providing target acquisition overmatch at night ("Exercise Showing Power of Digitization, Army Officials Say" 2001). With these enhancements, American armor has leapt past the modern ATGM and many other antitank assets whose destruction on future battlefields may come as a complete surprise when they are targeted by an American tank well beyond the human eye's ability to see.

Acquiring a target is one thing; killing it is another. While the M1A2 SEP provides significant stand-off acquisition thanks to its thermal sights, the fire-control system must support an accurate first-round hit capability to be truly successful. The M1 Abrams has this potential with an enhanced computerization that ensures every round counts. Beginning with the gun tube, the M1A2 Abrams has a dual axis Gunner's Primary Sight that provides precise gun tube orientation for improved first round hit probability ("Abrams M1/A2" 1999). For each round the Abrams fires, the targeting computer calculates a firing solution based on several factors: lead angle measurement, bend of the gun tube, wind velocity, and data from a pendulum static cant sensor found on top of the tank ("Abrams M1/A2" 1999). While this data is automatically calculated, the crew adds information on the ammunition type and temperature as well as the barometric pressure ("Abrams M1/A2" 1999). The result of inputting all of this data is an improved ability to achieve the one shot, one kill goal envisioned by the Army Research Laboratory. When training and doctrine are tied to this technology, the goal becomes closer and closer.

The technological advances of the SEP provide tank crews an unmatched targeting capability, but only if a well-trained crew executes the doctrine correctly. The SEP's "hunter-killer" capability allows the gunner to engage a target while the commander searches for and locks onto a new target with his independent thermal viewer ("Army Deploying M1A2 Abrams SEP Tanks, Digitized Equipment Overseas" 2003). This capability helps to ensure a faster targeting cycle than the enemy's, but only if leaders within the armor community ensure constant training on the skill--only through quality gunnery practice can this overmatch capability in target acquisition be accomplished. In addition to the technical aspects of gunnery, tank crews are taking lessons from OIF where tanks must be prepared for engagements against foes other than main battle tanks in an urban environment. The need to constantly update its tactical doctrine is not missed by the armor community. Major General Tucker discussed the need to update its precision gunnery simulations with new, realistic urban scenarios as well as live fire gunnery that places more emphasis on the tank's machine gun capabilities (2004, 4). While guidance is provided by the Armor Center's top general, it is apparently already understood in the field--one month prior to Major General Tucker's comments on gunnery in *Armor*, two soldiers addressed the same issue in detail. In the September-October issue of *Armor*, Major Skinner and Sergeant Dunfee outline the specific updates that must be made to armor gunnery given today's security environment. The proposed gunnery program will emphasize fighting in urban environments and stress the crew's ability to distinguish friendly from enemy targets with the goal of minimizing collateral damage (Skinner and Dunfee 2004). This security dilemma presents a significant challenge to the armor community--the requirement to shift their training focus towards a new threat while maintaining competency for the ever present threat of tank-on-tank engagements.

As technology edges the Abrams closer to a one-shot-kill capability, the opportunity for a "second chance" becomes dim; while this supports the armor's mission of destroying the enemy, it creates a small window of opportunity in preventing fratricide. In support of minimizing fratricide, the new SEP upgrade for the Abrams provides improved battlefield awareness for tank commanders, making it "a lot easier to figure where everybody's at" according to Captain Riera after the DCX ("Exercise Showing Power of Digitization, Army Officials Say" 2001). After training with the M1A2 SEP, the commander of the 1st Cavalry Division, Major General McKiernan, explained that the SEP connects the tank to the Army Battle Command Systems (ABCS), allowing every tank crew to visualize where they are positioned on the battlefield compared to their buddies and the enemy (Del Marcus 2001). In addition to the digital systems that provide situational awareness, the second generation FLIR stood as the top priority upgrade for the Armor Center in 1998 as they pursued the SEP program because of the fratricide preventive capabilities of the long distance sight (Harmeyer 1998). As long as fratricide avoidance remains a top concern of the American public, military leaders will continue to develop the technologies to help counter it.

Given the above analysis, it appears the armor community is training and fighting in a very dynamic time, even though every indication shows that the M1 Abrams will remain in the Army inventory for many more years. Making these evolutionary changes, some bigger than others, is critical to maintaining the currency of America’s most advanced main battle tank. According to James Dunnigan, small evolutionary changes, not any major breakthrough, in the tank produced the overwhelming victory during Operation Desert Storm in 1991 (1996, 68). Whether or not SEP will be considered a breakthrough or just another step needed to maintain overmatch may be debated by future analysts. Currently, it appears that the upgrade is producing significant, unprecedented results for tank commanders at the smallest tactical level. Such results will most certainly come in the form of defeated enemy tanks but they may also appear as limited collateral damage and fratricide--two important aspects of the current security environment needed to sustain public support and help win future wars.

The contrast between America’s last two conflicts with Iraq has been striking for the armor community. After the Iraqi army was decimated in the unrestricted desert, it appears they learned not to make the same mistake again. Avoiding open terrain where American armor has unquestionable overmatch and seeking urban venues for combat proved more challenging for the M1 Abrams. While this move was neither decisive nor successful, it did create an environment that forced the Army to rely more upon its most basic warfighting asset--the soldier and his rifle.

Direct Fire: Rifle

During an analysis of weapon's accuracy, one cannot overlook the value of the basic rifle in the conduct of warfare during the last several centuries. The implication of gunpowder in early conflict and its initial state of accuracy is best described by George and Meredith Friedman in *The Future of War*:

> Columbus and his heirs conquered the world because of the tube fired, chemical-explosive-powered projectile-the gun and bullet. Guns were effective because they permitted warriors to kill their sword-, spear- and bow-wielding enemies before those enemies could come close enough to do them harm. The gun's lethality was limited only by its inaccuracy. Thousand of rounds had to be fired to inflict a single hit. The European solution was masses of men firing masses of guns produced by masses of factories. (1998, 16)

The first "quantum leap" technological change that affected rifle accuracy was the invention of the conoidal rifle bullet in 1849; when fired from a muzzle loading rifle, it caused most of the casualties in the Civil War and forced a "revolutionary readjustment in infantry tactics" (Dupuy 1984, 292). Rifled weaponry during this era set off a "'precision revolution' in warfare" according to Major General Scales; this one occurring a century before the tank and ATGM revolution (2003, 17). The impact of this "revolutionary" capability was seen most dramatically in World War I--an imbalance between firepower and maneuver. Man's inability to cross "no man's land" during the Great War left military commanders with the challenge of resolving "the tactical and operational dilemmas imposed by the dominance of precision firepower" (Scales 2003, 17).

When the stagnant battlefield of World War I was replaced with dominant maneuver of World War II, Army commanders continued to emphasize the importance of precision marksmanship. During this conflict, however, leaders began to see a drop in fire efficiency. Any failure in precision cannot be blamed on the weapon; table 2 shows the indisputable trend in accuracy from the muskets carried by Columbus' men to those employing direct fire in World War I.

Table 2. Musket and Rifle Accuracy

Weapons	Accuracy
17th Century Musket	.55
18th Century Musket	.65
Early 19th Century Rifle	.8
Mid 19th Century Rifle with conoidal bullet	.9
Late 19th Century breechloading Rifle	.9
Springfield Model 1903 Rifle (magazine)	.95

Source: Dupuy 1985, 26-27.

The accuracy numbers in table 2 are based on Colonel Dupuy's definition of accuracy: "The probability that a single blow, aimed precisely at the target, will hit it must be considered as an inherent quality of the weapon and not the user, whose performance is affected by practice, training, excitement, and other outside influences (1985, 21). As the rifle's "inherent quality" achieved a statistical plateau at the start of the twentieth-century, any concerns over firing efficiency must be directed at the firer.

Some of the most publicized observations of combat fire effectiveness were recorded in S. L. A. Marshall's *Men Against Fire* in 1947. Marshall, contracted by the War Department as a combat historian to research tactical issues during the war, declared that less than 25 percent of infantrymen were effectively targeting the enemy (1947, 54). While Marshall's findings caused great controversy among some senior leaders, he claims that commanders at the company and regimental level agreed with his findings (1947, 8). Regardless of the disagreements, one can hardly ignore his point that the human element of warfare affects a man's ability to shoot effectively. During the years following World War II, the military conducted several studies to analyze this dilemma. A 1952 SALVO study (the term SALVO appears to refer to a salvo of bullets and not an acronym) published findings similar to Marshall's: battlefield stress causes soldiers to improperly aim their weapon, resulting in an excessive number of rounds needed to kill an enemy soldier (Lenaerts 1988, 16-17). Interestingly, Project SALVO accepted the fact that the average solider is an inefficient firer and sought technical solutions to the problem--principally a smaller bullet leading to the M16's 5.56-millimeter caliber (Lenaerts 1988, 16). Heading up the infantry division of the Operations Research Office, Norman Hitchman published "Operational requirements for an Infantry Hand Weapon" which recommended volume over accuracy; it claimed that if an infantrymen shot a four round spread of bullets twenty inches in width, it would be twice as effective (in terms of hit probability) against a target compared to a single shot from the M1 rifle ("Special Purpose Individual Weapons: A Brief History of Flechette and the SPIW Project"). The result of the SALVO study was an overall reservation against "developing and fielding a highly accurate rifles--which the average infantryman, under combat stress, is nowhere in a position to properly use" (Lenaets 1988, 16). Instead, the Army sought a new weapon, one with a smaller round and "controlled dispersion" to make up for "inherently poor accuracy" of the American soldier (Lenaets 1988, 16). When the M16 was developed in the 1960's, soldiers found in their hands a dramatically smaller caliber (5.56-millimeter) and a fully automatic setting for maximum firepower.

During the 1970s, Army professional journals were flooded with articles analyzing the American soldier's inability to shoot. A common theme existed throughout these critical writings--American soldiers, as a reflection of a changed American society, cannot shoot effectively. Lieutenant Colonel Wilcox noted in an article for *Infantry*, "Unfortunately, many soldiers coming into the Army today have never held a rifle before, and we are accepting a high probability of friendly casualties by failing to teach and re-teach all of our soldiers how to defend themselves" (1979, 18). During peacetime, such conditions could be overcome; however, earlier in the decade the nation was still at war in Vietnam and the draft was feeding the Army with new soldiers every month. Major Wigger reflected upon this dilemma in an article for *Army* magazine in which he states that the average replacement troop "could not hit a silhouette target a 25 meters, knew little of basic marksmanship fundamentals, and did not understand why he needed to zero his rifle" (1977, 12). Such poor performance by an initial recruit may be manageable stateside during basic training; however, Major Wigger encountered this situation within Vietnam immediately before sending soldiers into combat.

While rifle fire may have seen its zenith in World War I, it now appeared that the ability of a soldier to place effective fire on the enemy was in decline. The experiences in World War II and Vietnam implied that the Army had two challenges: one, make a better rifle that would assist the operator in ensuring an increased probability of hit; and two, improve what many agree is the most critical component of shooting straight--sufficient training.

In the decade following Vietnam, military leaders took action to fix the shooting discrepancy in the Army and re-introduce accuracy to the force. In 1986, two programs published plans towards this end. First, the Joint Service Small Arms Program (JSSAP) actively sought a replacement to the M16 rifle; their "paramount consideration [was] that the average infantryman's combat effectiveness must be improved through better hit probability and target acquisition/identification; as a second basic requirement, the man and rifle interface must be improved, particularly through higher sustainability and enhanced night vision features" (Lenaerts 1988, 27). One of the aims of the program was to develop the Advanced Combat Rifle (ACR); this weapon would succeed the M16A2 even thought the United States had just committed itself to the A2 model in 1983 (Lenaerts 1988, 19). While the ACR program was underway, the initial task for JSSAP was to improve the M16A2, primarily in terms of accuracy (Lenaerts 1988, 19). The program explored the use of advanced optics to give the M16A2 the necessary precision to remain a modern weapon; twenty years later these optics are being used extensively in current operations and will be discussed later in this chapter.

Also in 1986, several recommendations were outlined in another weapons study, *Small Arms Strategy 2000*; this one presented by the United States Army Infantry School at Fort Benning, Georgia. *Small Arms Strategy 2000* recommended a nearly complete overhaul of weapons used by soldiers over the next fifteen years and beyond. During an era of increased focus on more popular programs, such as aircrafts, armor and electronic technologies, the movement by Fort Benning was referred to as a "quiet revolution" and an "Infantry revolt" by Don Walsh, small arms editor of *Defense and Foreign Affairs* in 1987 (1987, 38). While short-term replacements reduced the current weapons array from ten to seven, the long term outlook consisted of an ambitious plan to reduce this arsenal to only three, highly accurate weapons: Advanced Personal Defense Weapon, Advanced Crew Served Weapon, and the Advanced Individual Combat Weapon (AICW) (Walsh 1987, 38-39). The AICW, which would replace the current M16A1 as the Army's infantry weapon, required a "first round hit probability" of 90 percent at 500 meters day or night; the new crew served weapon also required a 90 percent accuracy rating, day or night, but at 1,000 meters (Lenaerts 1988, 24). Critical of the proposal, Don Walsh questioned the likelihood that weapons could be built to such specifications (1987, 39). Similarly, Jacques Lenaerts, writer for *Military Technology*, stated that while the Infantry School study was bold and ambitious, it remained purely theoretical--the proposal envisioned "the infantryman being equipped with something akin to a miniaturized, and highly accurate Mk 19" (1988, 24). The AICW (or the ACR) never replaced the M16, which remains today as the standard Army rifle. While Lenaerts and Walsh were most likely correct in their analysis, this report does reveal the Infantry School's motivation to develop enhanced weaponry with extremely high accuracy ratings.

While Fort Benning's report yielded no change to the base weapon that the American soldier was carrying into combat, the Army still possessed the same task outlined by JSSAP--improve the rifle to ensure greater hit probability, target acquisition, and night vision advances (Lenaerts 1988, 27). Today, soldiers in OEF and OIF carry a version of the M16 (either the A2, A3 or A4 model) or its M4 carbine equivalent;

although the weapon has the same basic functions as earlier models used in Vietnam thirty years prior, the weapon looks very different. The differences in appearance are not cosmetic--the rifle possesses a new set of optics and lasers that the military leadership envisioned twenty years earlier. When combined with night vision devices (NVDs) (i.e., goggles), the weapon can also accurately engage targets during conditions of limited visibility. This nighttime capability yielded a movement in the Army during he 1990s to own the night. “Own the night” was an Army campaign to demonstrate the American soldier’s unmatched ability to fight during periods of limited visibility. While many critics have challenged the concept as overly ambitious, the campaign does reflect the effort taken by the United States military to develop a nighttime fighting capability.

Today’s version of the M16 rifle in combat normally combines the M68 close-combat optic (CCO) and either an AN/PAQ-4 laser or AN/PEQ-2 aiming light. The CCO sight “uses a red dot aiming point . . . the dot follows the horizontal and vertical movements of the gunner’s eye while remaining fixed on the target” (Department of the Army 2003). This sight is designed to provide the shooter a precise point of aim without requiring the operator to “line up” iron sights. Firing tests revealed that while the CCO produces only a minimal increase in accuracy, the real advantage in using the CCO is quickness in engaging multiple targets (Harris 1999, 24). Speed and accuracy are two fundamentals necessary for fighting on today’s congested battlefield, such as an urban environment where many modern engagements are fought. For accurate target engagement at night, soldiers attach either the AN/PAQ-4 or AN/PEQ-2 to their rifles. Each device points an infrared laser beam, aligned to the barrel of the rifle, towards the target; the laser is viewed by the shooter through his NVDs. The result is highly accurate rifle fire because the laser is boresighted to the weapon using a device known as a "borelight." Boresighting the weapon allows for "full accuracy" without requiring bullets to zero the weapon (Boatner 1998, 33). While generations of infantrymen only experienced shooting with iron sights during the day and guesswork at night, the combination of the CCO, laser designator, and night vision goggles are now the standard in every American infantry unit.

When used in combat against a foe without the same capability, the effect can be significant, according to Army Captain Daniel Morgan upon returning from operations in OIF:

> Marksmanship is the core of excellence for infantry soldiers. Their proficiency in killing wins the battle. The more you suppress the enemy here without killing or wounding him, the bolder he becomes in attacking you. You need to train your soldiers to aim, fire and kill. If an enemy opens fire with an AK-47 aimlessly, which most of these people do, you should be able to calmly place the red dot reticule of you M-68 optic device [CCO] on his chest and kill him with one shot. If you do this, the rest will run and probably not come back. This skill takes training, patience and sadly, experience. (2004, 24)

While the CCO is a significant sighting improvement over the rifle's traditional iron sights, it is already a decade old and the military continues to seek improved devices to assist the shooter in identifying and engaging the correct target--one of these advances is a telescopic sight (i.e., scope). In an article for the *Marine Corps Gazette* in 2004, Chief Warrant Officer 3 Eby explained the disparity that exists between Marines shooting with or without a telescopic optic. Three weeks prior to entering Iraq during OIF, eighty-one members of Eby's unit received an M16A4 equipped with an Advanced Combat Optical Gunsight (ACOG), a four-power telescopic capability (Eby 2004, 50). According to another Marine in the same division, "This marks the first time in the history of the Corps that Marines at the squad level have gone into combat with scoped weapons. This has been a long time coming and well worth the wait" (Colleton 2004, 46). The most significant capability that the new weapons possessed was an enhanced ability to confirm the identities of potential targets; Eby, who entered Iraq without the ACOG, had to rely on a separate set of binoculars to identify the enemy as targets came into range of his M16 (Eby 2004, 50).

It may appear that the eighty-one Marines who used the ACOG to engage enemy targets in OIF were simply applying another evolutionary enhancement to the rifle; however, due to the new security environment in which they were operating, the effect was much farther reaching. Similar to how a demand for minimizing collateral damage contributed to the development of precision arms in air and artillery delivered weapons, the complexity of the modern battlefield mixed with both combatants and noncombatants also requires an improved accuracy capability for infantrymen (and other combat arms soldiers acting as infantrymen--a common practice in OIF). Chief Warrant Officer 3 Eby does an excellent job of explaining the connection between this type of direct fire enhancement and the modern GWOT battlefield:

> The days of our opponent wearing a distinctive uniform to assist us in identifying him may well be long gone. Everyone looks alike at ranges beyond 150 meters, and weapons are not nearly as distinctive in urban environments as you would expect. Equipping Marines with this capability will surely prevent or reduce noncombatant engagements during future battles. (2004, 50).

Another Marine gunner in Eby's unit agrees with the impact of the enhanced capability; he states, "There are many Marines out there who are very proud, not of the shots they took, but of the *shots they didn't take*, or their buddy didn't take, because of their ability to identify targets." (Colleton 2004, 47). For Army light and mechanized infantry units operating in OIF, the first place a scoped rifle can be found is at the battalion level in the

Scout Platoon. If commanders desire to share these assets with squads, platoons, or companies, a separate task organization must be made for an operation. Although these critical assets were not organic to his company, Army Captain David L. Buffaloe made full use of the battalion snipers during OIF because “precision shots are crucial during a low-intensity conflict due to the requirement to minimize collateral damage” (2004, 9). Fighting elsewhere in Iraq was Sergeant Williams of the 1st Armored Division. In a letter to *Infantry*, Sergeant Williams called for a greater use of snipers after reflecting upon his unit’s experiences on today’s urban battlefield (2004, 3). According to Sergeant Williams, “leaders realized that they couldn’t just level an apartment building that had an RPG [rocket propelled grenade] team in it because there were also families in that same building…they couldn’t use the coax (machine gun) on the enemy because there were too many civilians running around in front of them” (2004, 3). In light of these examples of Marines and soldiers using scoped weaponry in OIF, it should not be a surprise that the Army is re-looking its use of snipers and sharpshooters, causing a significant organizational change to units in the Army.

First, a general discussion of snipers is necessary. It is important to note that the purpose of this thesis is not to recommend that the Army’s ranks be filled with an all-sniper force. An Army of snipers would be a one-dimensional force, without the maneuverability that combat demands. Snipers are specialists and their training is extensive and task-specific; expecting all soldiers to train and perform to the high standards of Army and Marine snipers would be an impossible feat. Given this assessment, the Army can still place more emphasis on these highly accurate marksmen. In fact, as the Army transforms itself at the beginning of the twenty-first century, it is making several organizational changes to include snipers below battalion level. The first organizational change was made to the Army's Stryker Brigade--an all-wheeled, C-130 deployable force designed to project combat power by placing infantry and cavalry soldiers quickly into battle while still providing them armored vehicle protection. The Stryker Brigade is made up of three infantry battalions, comprised of a total of nine Infantry companies; each company will possess a three man sniper team (Department of the Army 2002, A-2). It has already been stated that all soldiers cannot be trained and employed as snipers; however, the requirement for improved marksmanship remains at the lowest levels of infantry units. The Army's solution to this dilemma is the Squad Sharpshooter, otherwise known as the Squad Designated Marksman (SDM).

Previously discussed in this chapter was the use of a telescopic sight, at the squad level, for Marines engaged in combat during OIF. While these Marines were successful, based on reports in the *Marine Corps Gazette*, one could make the argument that not every soldier needs a scoped rifle. The basis for such a position is well communicated by Lieutenant Colonel Harris in an *Infantry* article: "There are no gadget solutions to marksmanship training. A marginal shooter with a sniper rifle is still a marginal shooter" (1999, 24). An SDM-type program, according to Lieutenant Colonel Harris, is designed only for those soldiers who are already expert marksmen (1999, 24). As a point of reference, in 2004 only 4 to 6 percent of trainees qualify expert with their weapon, according to one training unit at Fort Sill, Oklahoma (Baker 2004). Lieutenant Colonel Harris also points back to the Marine Corps who were among the first to possess such a program along with the Army Ranger Regiment; both of these organizations selected two or three soldiers per squad to shoot with a four-power scope (1999, 23). In 2004, the

Army's Chief of Infantry, Brigadier General Freakley, announced that the SDM program is a key step in developing efficient infantry marksmen who could engage the enemy with great precision (2004, 2). According to Brigadier General Freakley, in a message to all infantrymen, "Today's adversaries are capable of delivering a high volume of fire against us with assault rifles, but they often do so at the cost of accuracy" (2004, 1). To combat this, every infantryman must be able to calmly shoot in a manner described by Captain Morgan; the addition of an SDM program would nearly guarantee an accuracy overmatch against this type of enemy. In order to produce such marksmen, the Army SDM program places select soldiers through a demanding one week program in which firers shoot over 2,500 rounds and are instructed in advanced marksmanship techniques (Freakely 2004, 2). This program is directly affecting units deploying to OIF today. As the 3rd Infantry Division prepared to deploy, it reported full implementation of the SDM program--each maneuver battalion and armed reconnaissance squadron possessed 20 SDMs each (G3 Operations, 3rd Infantry Division 2005). Additionally, each shooter was provided a custom M16A4 with a match barrel and trigger built by the Army Marksmanship Unit in Fort Benning (G3 Operation, 3rd Infantry Division 2005). The fact that 3rd Infantry Division received support from the Department of the Army, Training and Doctrine Command, and the Army Marksmanship Unit shows the level of emphasis that exists for improving accuracy in its direct fire units.

Previously stated, the Army has sought two paths in improving marksmanship on the battlefield; one, with a better rifle and two, with improved training. While the optics and lasers have produced an updated weapon and the Army has provided better shooters with even better arms and ammunition, the common denominator for all soldiers, whether snipers, SDMs, or truck drivers, will always be training. Although it is difficult to imagine any military professional who would not regard training as a critical component to weapons effectiveness, military history has shown that leaders must be willing to accept change in the conduct of that training. Described in *Infantry*, the lesson of flexibility and marksmanship were experienced by the British a century ago:

> At Colenso and Spion Kop, the Boers used steady and accurate rifle fire to win the day. . . . From their superior perch, the Boers delivered such accurate rifle fire that British soldiers could not rise above the shallow trenches they had dug without fear of a bullet in the head. The British drew some of the correct lessons. After the end of the Boer War, they began rigorously training their infantry in accurate and sustained rifle fire. This was so successful that when the Germans collided with the British Army near Le Cateau, they believed the British had hundreds of machineguns in their line. They didn't. It was the British infantry firing just as the Boers had done before the turn of the century. (Wright 2000, 14)

The United States military has shown the same awareness for change in its marksmanship training. Similar to the critiques of Army marksmanship skills of the Vietnam era, one only has to peruse professional journals such as *Infantry* and the *Marine Corps Gazette* over the last two decades to see that soldiers and Marines continue to be concerned when they foresee training not keeping up with technology and tactics. Both officers and non-commissioned officers are constantly analyzing current training models and making recommendations ranging from complete overhauls of marksmanship instruction to "Master Gunner" programs for light infantry units. In 2002 a group of soldiers for the 82nd Airborne Division described this latter concept as a needed program given the fact that "the influx of NVDs, optics and lasers have given light forces an unprecedented opportunity to own the night in a small arms clash. Yet to date the potential of this increased capability has not been fully realized." (Frost, Jackson, and Valdez 2002, 32). This last point shows that soldiers are fully aware of the impact that technology is having on their profession and they have a responsibility to ensure training maintains pace with it.

In 1998, the Army's Infantry School established new training doctrine for every infantryman. It was obvious to many at the time that the technologies listed in this thesis were outpacing the TTPs necessary to use them effectively. This doctrine, published in Training Circular 23, *Advanced Infantry Marksmanship Strategies and Standards*, was distributed to every senior officer and non-commissioned officer leader in the infantry (Boatner 1998, 32). According to Lieutenant Colonel Boatner, commander of the unit tasked to develop this training doctrine, basic rifle marksmanship fundamentals had to change due to the addition of modern technological enhancements for the rifle (1998, 32). Specifically, aiming and achieving a steady position were two basic principles of marksmanship that required adaptation given the lasers, optics, and NVDs worn by soldiers (Boatner 1998, 32). The Marines are experiencing a similar dynamic when technology collides with a unit steeped in marksmanship tradition. Chief Warrant Officer 3 Eby, in his article for the *Marine Corps Gazette*, described how the CCO requires techniques of "two eyes open" shooting and "flash, front sight, press" drills for rapid accurate engagements; Eby states that such procedures challenge Marine Corps tradition and will require a shift in mindset to become effective (2004, 51). Eby concludes his article by stating that the Marines must adapt their rifle training away from medal-winning competitive shooting and towards preparation for war (2004, 51). While the Marine gunner's intent is probably sound, the Army has found a way of leveraging their Olympic caliber shooters, assigned to the Army Marksmanship Unit, in order to prepare the average soldier for war. In 2004, members of this elite shooting unit traveled to Iraq to train members of the 1st Armor Division in advanced combat marksmanship ("UASMU Shooters return from training soldiers in Iraq"). It was stated previously in this thesis that this unit provided the 3rd Infantry Division SDMs with custom weapons in preparation for OIF. Using the Army's best marksmen in this unmatched technical and tactical capacity simply shows one more way the military is adjusting to meet the demands of precision marksmanship.

The Army's reliance on using expert marksmen to train inexperienced shooters has stood as a basic training model for as long as most veterans can remember; however, today's Army has moved well past that model and includes computer simulations to assist in the training of basic marksmanship skills. While simulations will never fully replace the benefits of live fire ranges, one cannot ignore the environmental and resource constraints (i.e., infrastructure, transportation, ammunition, time) that came from relying completely on traditional weapons ranges (O'Malley 1993, 31). In addition to cost savings, the training benefit is very real; a soldier who conducts marksmanship training on a simulator is significantly better prepared to perform on a live fire range at a later date (O'Malley 1993, 31). While the Army began using simulators on live fire ranges in order to assist only poor shooters, modern training programs use these computerized systems as a base training tool before valuable ammunition is expended on outdoor ranges. One example of this is at the United States Military Academy at West Point; first year cadets first conduct marksmanship training on the Laser Marksmanship Training System (LMTS) before ever stepping foot on a live fire range. The benefit of this training at West Point is twofold; one, it improves the cadet's marksmanship skills and two, it introduces one of the Army's latest technical training model to future small unit leaders.

The LMTS allows officers or non-commissioned officers the ability to setup a marksmanship range inside almost any building (or outside with access to electrical power) and requires the firer to simply exchange his weapon's barrel for a modified one, thus allowing the soldier to use his own weapon for training. The simulation's greatest benefit is that it allows the soldier to focus on the same marksmanship fundamentals that produce precise targeting on a live fire range. While critics of systems, such as the LMTS, may argue that environmental and combat conditions can never be simulated, developers are striving to meet that challenge as well. Modern simulators, such as the Engagement Skills Trainer 2000 place groups of soldiers before a large, wall mounted screen that produces numerous combat scenarios in almost any set of conditions. The system "combines marksmanship skills, judgment training and collective combat training" with the benefit of precise feedback--at the end of each scenario the soldier receives a scorecard reflecting the exact position of all of his shots, both hits and misses (Ezel 2001). For the trainer, the results are produced in real time; instructors can provide feedback faster than a traditional rifle range (Kutner 1999). Critics of computer simulators may argue that the Army is attempting to minimize live fire training; however, if used correctly, simulations should only augment and not replace live exercises. It is important to remember what is motivating the Army to develop these new, increasingly realistic training systems; while cost and resource limitations are certainly valid motivators, the primary purpose is to improve the soldier's ability to shoot accurately, thus meeting the demands of the Army's leadership and the American public.

A great deal of effort has been made in this thesis to show the improvements in developing modern firearms; however, how much impact can a simple rifle have on the modern battlefield? An example from one of the Army's sister services, United States Coast Guard (USCG), is useful to show the effectiveness of a modern weapon in conducting small unit operations. For years, the USCG has been challenged by drug traffickers using extremely fast speed boats to outrun Coast Guard vessels. Since 1999, the USCG has employed snipers aboard Coast Guard helicopters to disable these speed boats; prior to using this technique, boat crews were limited to using their slower vessels and deck-mounted machine guns. In an article entitled "Stop Drug Boats with Precision Marksmen," Lieutenant (junior grade) O'Neill (USCG) and Lieutenant Commander Chris Robinson (United States Navy) describe a new procedure for defeating these "go-fast" boats (2003, 89). O'Neill and Robinson seek a more effective way of accomplishing the mission by adding the capabilities of the Navy to the counterdrug tactics. Currently, the Navy's Light Airborne Multipurpose System (LAMPS) helicopters and Sea Air Land (SEAL) snipers assist the USCG in the Arabian Gulf during landing party operations. According to O'Neill and Robinson, the "unique command-and-control capability of the LAMPS, mobility of the helicopter, and accuracy of the SEAL sniper are an ideal combination for a mission that requires limited and precise applications of force" (2003, 89). While using the wartime organization during counterdrug operations off the shores of the United States would be dramatically different due to legal issues that restrict fires from originating on Navy aircraft, O'Neill and Robinson propose using Coast Guard snipers aboard the Navy air and sea assets (2003, 89). Using the Navy in this counterdrug role would be a doctrinal change for the force; additionally, while the tactics would be similar, forming a habitual USCG-Navy organization of this kind would employ modern technology (e.g., FLIR imagery aboard Navy helicopters and the USCG's M-82A1 .50-

caliber rifle) in these operations (O'Neill and Robinson 2003, 89-90). The reasoning behind the recommended change is consistent with other examples in this thesis that seek tactical solutions while reducing risk; due to the LAMPS's stable platform and agility, employing them would minimize the "likelihood of killing or wounding go-fast crewmen with errant rounds" (O'Neill and Robinson 2003, 90).

It is clear that this Coast Guard example combines modern rifle technology with some change in tactics, organization, and doctrine used to defeat drug traffickers on the open seas. Given these changes, one could argue that the innovation could be considered either an evolutionary or revolutionary design. The answer lies within the context of the organization: for the DOD, the change is very significant; however, for the USCG sniper and pilot of a Navy LAMPS helicopter, who are experiencing a dramatic change in the way they conduct their form of warfare, the change is possibly very revolutionary. Similar to the changes for the Javelin ATGM, which has shown revolutionary impact on SGT Hyder who can now kill enemy armor and protect himself, for the United States Army the changes in wireless technology and man portability are simply evolutionary.

While some can argue these semantics, there is a broader question: When all of these ground systems are combined on current and future battlefield, what is the impact? What will be the results of a combined arms precision capability from infantry and armor--especially when added to the increasingly accurate capabilities of artillery and joint precision fires from the Air Force?

Impact of Combined Arms and Joint Precision

In their 1998 book on future war, George and Meredith Friedman stated, "Accuracy, and the technology necessary to produce that accuracy, had been the driving force of American military culture" (1998, 16). The context in which this statement was made referred to America after World War II and its quest for a military more reliant upon high-technology machines instead of masses of men. Although the United States currently possesses one of the largest active armies in the world, many would argue that today's military culture fits this model even better than in previous decades. Herein lays the impact of precision upon current and future campaigns: a culture of super-accuracy that has changed the way military professionals think as well as employ units in combat (i.e., tactics). While the future of combat shows little change in the existence of a precision culture, other than an increase in its emphasis, tactics will certainly change based on the technologies discussed in this thesis.

First, a culture based on precision will only stubbornly continue to drive military thinking. This thesis has shown that this culture exists due to the external pressures to limit collateral damage and fratricide. As the public continues to place expectations on the military in exchange for its support, the military will continue to look to technology for many of the answers. Even when national will is not the motivator, cost and efficiency will be; according to Richard Connaughton in *The Nature of Future Conflict*, "The more accurate the munitions, the smaller the logistic dependency. The burgeoning cost of modern weapons and their ammunition is also contributing to the demand for a first-round hit probability" (1995, 150). In addition to firepower and logistics, tomorrow's military culture will use precision to define all of its systems; William W. Hartzog and Susan Canedy predict that precision will become "part of every operational pattern" within the Army (Pfaltzgrff and Shultz 1997, 171). If a casual observer were to sit through a military briefing today, they would understand quickly what Hartzog and

Canedy meant; the term “precision” has been applied to nearly every aspect of Army operating systems--precision engagement, precision fire, precision artillery, precision intelligence, precision marksmanship, precision strike, precision logistics, precision attack, and precision mortars are just a few examples of current military terms.

Whether or not the impact of a precision culture is a positive or negative one is most likely best left up to the individual. Any student of military history or military science can see the obvious benefits to precision weaponry and their effects. At the same time, there is validity to the argument that a culture based on precision, dependent more on machines than men and fearful of collateral damage and friendly losses, sets a dangerous precedent for future soldiering. Those favoring the latter would argue that there are many aspects of combat that have nothing to do with technology; military theorist Karl von Clausewitz’s definition of war as “an act of force to compel our adversary to do our will” seems to support this stance (Carr 2000, 264). Current critics of this trend, such as military veteran and author Ralph Peters, acknowledge the benefits of technology, but believes it can also “lead to fatal dependencies” (1999, 7). The best answer to the qualitative nature of precision is probably somewhere between the two arguments; in short, any technological advantage that helps to defeat the enemy’s will would almost certainly find favor by many critics, even Karl von Clausewitz.

This thesis has highlighted several of the tactical impacts of precision in America’s current arsenal of ATGMs, tanks, and rifles. When each is analyzed separately, the advances of the last two decades appear to be mere evolutionary gains; however, when combined, especially with artillery and joint fires, there are definite indications of significant tactical change similar to previous historical examples.

Specifically, many argue that the existence of precision technology is causing an imbalance between firepower and maneuver. One of the indications of such an imbalance is the dramatic dispersion of forces on the battlefield; this phenomenon is occurring now and it seems logical that this trend will only continue. Overall, few can argue that there will not be changes in the employment of forces in future battle; the only question remaining will be the degree of change.

A brief look at a history of military formations reveals a steady growth in the dispersion of forces on a growing battlefield. Table 3 shows the historical comparison of unit densities since the first ancient formations.

Table 3. Expanding Battlefield

Area occupied by deployed force 100,000 strong	Antiquity	Napoleonic Wars	U.S. Civil War	World War I	World War II	October War	Gulf War
(square Km)	1.00	20.12	25.75	248	2.750	4,000	213,200
Front (km)	6.67	8.05	8.58	14	48	57	400
Depth (km)	0.15	2.50	3.0	17	57	70	533
Men per sq km	100,000	4,790	3,883	404	36	25	2.34
Sq meters per man	10	200	257.5	2,475	27,500	40,000	426,400

Source: Sullivan and Dubik 1995, 13.

Major General Scales illustrates this trend over the last 150 years of battle:

> The battlefield will continue to empty as armies seek to lessen the destructive effects of precision firepower. Again, this is a continuing and spontaneous process that has been with us since the first precision revolution started thinning the battlefield with the introduction of rifled ordnance in the mid nineteenth-century. Union and Confederate forces at Gettysburg were packed to a density of approximately 26,000 soldiers per square mile. On a World War II European battlefield a firefight on terrain similar to Gettysburg might involve several battalions of about 3,000 men. In Desert Storm the battlefield of Gettysburg could easily have been covered by a mechanized company in the attack. (2000, 77-78)

Major General Scales predicts that an increase in precision weapons will only continue to thin ranks and disperse forces into small elements spread out over the future battlefield (2000, 78). Today's commanders are experiencing this already. Lieutenant Colonel Riera's participation in the DCX with the M1A2 SEP revealed a battalion frontage twice the size of a nondigitized battalion ("Exercise Showing Power of Digitization, Army Officials Say" 2001). Extensive dispersion may produce some surprising effects; Major General Scales believes that isolated cells separated by vast distances could prove to be an effective defensive posture to withstand volleys of precision strikes (2000, 78). According to General Sullivan and Colonel Dubik, this type of battlefield would stress the importance of unit cohesion and decentralized control--two aspects of combat not normally associated with precision engagement (2003, 14). While the second and third order effects of the future expanded battlespace remain questionable, history has shown a predictable pattern that dispersion will continue. The same predictability cannot be made to the question of maintaining a balance between two key elements of combat power: firepower and maneuver.

The balance between firepower and maneuver is "one of the immutable principles of warfare" according to Major General Scales (2000, 79). History has shown that an imbalance between these two combat power elements normally results in a dramatic effect. World War I's firepower dominance and stagnated maneuver led to trench warfare and the loss of millions of soldiers on European battlefields. Twenty years later, maneuver outpaced modern, yet poorly employed, firepower assets as German forces broke through the French Maginot Line. Today, firepower appears to hold the most potential for dominance based on the many capabilities analyzed in this thesis. It is improbable that firepower will dominate maneuver with same results as World War I, but warfare is rarely predictable. While some may consider the issue academic, Lieutenant Colonel Antal is not one of them; in an article for *Army* magazine he states, “The question of whether or not precision strike systems obviate maneuver will decide the future shape of America’s military” (1998, 42). Lieutenant Colonel Antal cautions the Army from becoming too attached to a precision strike strategy--doing so would require perfect knowledge of enemy positions on the battlefield; such a capability, if possible, would come at a substantial monetary cost (1998, 42). Major General Scales agrees with Lieutenant Colonel Antal’s warning; when an imbalance occurs between firepower and maneuver, the stronger element is then vulnerable to attack (2000, 79). It is possible that any further improvement in firepower may create conditions for a future enemy to successfully maneuver against American in a way that may not be anticipated. Information attack, perhaps a futuristic tactic of maneuvering through cyberspace, could dramatically affect the ability to deploy many precision munitions. Another response may be that firepower dominance drives an adversary to solely fight in urban environments where PGMs are less effective and maneuver from within buildings and sewers, while limited, can be decisive. If American military doctrine is any indication of predicting the future, *Joint Vision 2020* implies a balanced approach through four non-prioritized fundamentals: dominant maneuver, precision engagement, focused logistics, and full dimensional protection. It appears that the military is prepared to maintain the necessary equilibrium in doctrine; according to former Chairman of the Joint Chiefs of Staff General Reimer:

> For the nation to be decisive in war, our enemies must be presented with complex military problems beyond their ability to solve. We must maintain an adequate balance between our capabilities to assure that adversaries cannot and will not solve the military puzzle that we pose. Precision strike is important, but it is not adequate. Balance between precision strike and dominant maneuver is required. (Antal 1998, 46)

Whether or not the United States military can achieve its goals of balancing firepower with maneuver over the next fifteen years will remain a question. What should not remain a question is whether or not improvements in accuracy in today's direct fire systems will have a significant impact on tomorrow's battlefield. This chapter has shown that advances in optics, lasers, and fire-control systems are causing dramatic changes in the way soldiers train, organize and fight small unit engagements today and in the immediate future.

CHAPTER 5

CONCLUSION

> Consider this: What if the shooter pointed his weapon in the general direction of the target, pulled the trigger, and then let the weapon's fire control system decide when to fire the round? What if an infantry weapon and its ammunition could be integrated to give the ammunition the same mid-flight self-correcting capability being developed for larger weapons? (1997, 32)
>
> Virginia Hart Ezell, *National Defense*

This thesis has analyzed the current state of precision fires among the Army's man-portable and maneuver systems in order to show the affect these fires are having and will continue to have on modern battle. Throughout the analysis, historical examples have provided a background to today's increasingly accurate weapons. While the evolutionary nature of weapons development is obvious, several of today's innovations provide unprecedented capabilities and may be considered revolutionary--at least at the tactical level of war where engagements are fought by small units and individuals. This chapter will discuss the validity of defining precision direct fire systems in terms of a Revolution in Military Affairs (RMA) as well as describing the future of these capabilities during the next ten to fifteen years.

RMA became a popular term in the United States military during the 1990s to describe what many considered to be a dramatic change in the conduct of warfare at the end of the twentieth-century. MacGregor Knox and Williamson Murray define RMA in their book, *The Dynamics of Military Revolution, 1300-2050,* as "a complex mix of tactical, organizational, doctrinal, and technological innovations in order to implement a new conceptual approach to warfare or to a specialized sub-branch of warfare" (2001, 12). Knox and Murray identify several past RMAs in recent history: submarine warfare, radar, strategic bombing, and combined-arms tactics (2001, 13). In contrast, an evolutionary innovation is defined by Murray and Allan R. Millet as a long process "tak[ing] place over extended periods during which tactics, equipment, and conception change on a gradual basis" (1996, 308). Given these definitions of revolutionary and evolutionary change, there may still be difficulty in committing precision ground fires to one or the other. A third explanation may be valuable here; according to retired Lieutenant General Van Riper, an innovation can be considered an RMA only if it solves a military problem (11 March 2005). Given this definition, one can see how some problems have been solved with many of the systems discussed here; for example, the Javelin's fire and forget technology solved the problem of force protection for the gunner and enhanced optics and lasers provided the M16 rifle and M1A2 SEP tank an unprecedented ability to "own the night" and fight almost as effectively as during daylight.

While it appears that military problems have been solved with improved technology, the impact is most likely limited to the tactical level. The invention of neither the Javelin, M1A2 SEP nor M16 rifle solved any operational or strategic problems. In other words, theses weapons have not changed the role of the ATGM, tank or rifle; they simply have a marked advantage against their opposition. While this reality will not provide these systems the title of "RMA," soldiers using the weapons will not be concerned; they will embrace the advantages these weapons provide because they offer greater efficiency in targeting and destroying the enemy.

This thesis has argued that the conduct of war, as executed by the American military, is changing based upon a trend towards precision firepower in its ground forces. While these changes are evident during the ongoing conflicts in Iraq and Afghanistan, the concept of change will continue for several more decades. Although the analysis presented here is limited to current changes that will affect the military over the next ten to fifteen years, one must be aware of future developments that will be introduced to the battlefield during this same time period.

As the American Army transforms its ground forces at the start of the twenty-first century, this modernization effort includes a new suite of vehicles and weapons. In 1999, a *Defense Daily* article described a new "enhanced accuracy gun system," consisting of smart and maneuverable projectiles that could replace the entire fleet of tanks and personnel carriers (Keeter 1999). As of 2005, this technology appears to remain a distant goal; the Army has now focused its efforts on the Future Combat System which includes an array of combat vehicles not entirely different than the fleet currently used. According to a modernization bulletin written by the Association of the United States Army in *Army* magazine, these vehicles include a Mounted Combat System (i.e., tank), infantry carrier, self-propelled cannon, command and control vehicle, self-propelled mortar, reconnaissance platform, and medical vehicle (Steele 2005). Given the similarity between this list and the Army's current array of combat platforms, it appears the role of future armored vehicles will not dramatically change; however, the capabilities of each system will almost certainly be enhanced similar to the advantages the M1A2 SEP is providing to troops in OIF today.

Similar evolutionary development is occurring with the infantryman's rifle. After nearly forty years of service to the Army, the M16 rifle may soon be replaced by the XM8 rifle. The replacement is not due to any lack of precision from the older rifle; in fact the M16 has outperformed both the M1 and M14 in most interservice and national competitions, according to Lieutenant Colonel David Liwanag, commander of the Army Marksmanship Unit (7). The advantage to the XM8, also known as the objective individual combat weapon, is that it possesses the many M16 enhancements discussed in this thesis; however, rather than soldiers carrying a weapon with multiple devices bolted to the outside of the rifle, the new rifle will include the same capabilities in an integrated system. The XM8 appears to be merely an evolutionary design and it is doubtful that it will alter the role of the infantry in combat. What will change, however, will be the training and efficiency of the individual rifleman--who will use optics, similar to the CCO, as the rifle's primary sight to acquire targets. Since iron sights have existed as the weapon's primary sight since the birth of handheld firearms, this change will certainly appear significant to generations of infantrymen.

While this thesis has demonstrated the presence of several changes as a result of significant improvements seen in direct fire accuracy, it is important to understand what will not change. It has been stated throughout this chapter that the role of armor and infantry will remain unaltered--this is almost a certainty. While it seems that advances in precision firepower will affect the tank's survivability, there will always be a need for tanks on the future battlefield. Enemy tactics such as camouflage and deception, used effectively from Vietnam to Kosovo, require the need for armored vehicles in the close fight regardless of the terrain (Ogorkiewicz 2002, 42). This thesis has shown that accuracy of fires, from airborne, artillery, mortar, or vehicle platforms, will continue to drive the enemy towards urban areas where close combat is measured in meters. While armor forces adapt to this reality in Iraq, this battlefield is dominated by the infantry and its hand-held weapons. Many military analysts highlight this shift to an urban venue, but this is nothing new; armies have fought in cities throughout the twentieth-century. Close combat, whether it is fought in urban or wooded terrain, will continue to be the reality for both armor and infantry units. Major General Scales states that battles fought within the last fifty years "have all too often been fair fights" where technological parity existed between forces (2003, 29). Given this, one must look for an advantage, or unfair conditions, that will lead to American victory. Within the close fight, improvements in accuracy will help provide that advantage.

This thesis has shown that precision is gained through a combination of technology and training, allowing the gunner to both acquire a target and engage it more effectively. The technology component to this equation exists in a combination of optics, lasers, and fire-control systems among infantry and armor weapon systems. Soldier training on these systems is critical to providing the advantage needed to win battles; training not only ensures these systems are optimized, but it also allows soldiers to adapt to new environments--this is seen today with the M1A2 SEP tank being effectively employed within the city limits of Baghdad, Iraq. Operations conducted by American ground forces over the last two decades show why accuracy is so critical to success--force protection and avoiding collateral damage are key byproducts of accurate fire that help sustain the support of the American people as well as the local populace. While these improvements are mostly evolutionary, the tactical implications of these precision fires are certainly dramatic for the soldiers and small unit leaders who employ these weapon systems. As the Army re-designs its force structure at the start of the twenty-first century, it does so based on recent improvements in precision capabilities as well as anticipated models that will remain consistent with a precision culture overtaking the military. In the end, while the rifles and tanks may look and operate differently than they did for past generations, the goal remains the same for soldiers in close combat, achieving an age-old axiom: “what can be seen can be hit, and what can be hit can be killed” (Scales 1994, 10). It appears the American soldier is closer than ever to this objective, but it will require infantry and armor units to close with and destroy the enemy in many of the same ways they have for decades.

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