A STUDY OF AMMUNITION CONSUMPTION

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

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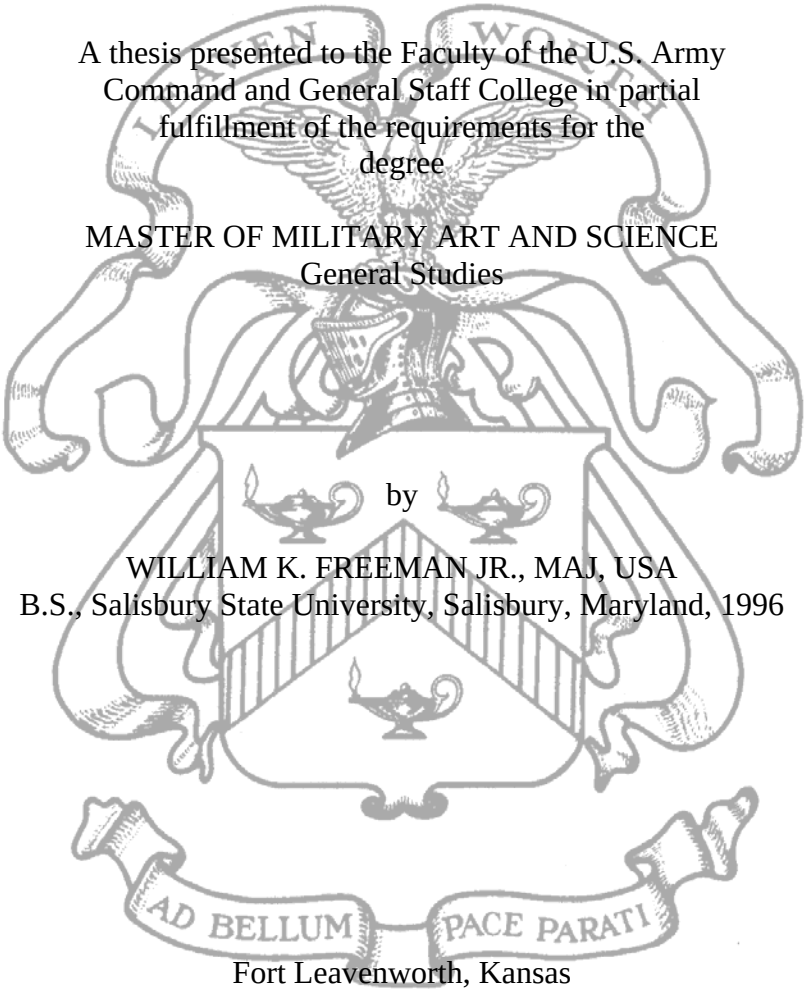

Fort Leavenworth, Kansas
2005

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
16 JUN 2006		

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Study of ammunition consumption.	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
William Freeman, Jr.	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army Command and General Staff College,1 Reynolds Ave.,Fort Leavenworth,KS,66027-1352	**ATZL-SWD-GD**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

The original document contains color images.

14. ABSTRACT

The purpose of this research was to investigate the United States Army?s ability to correctly estimate and forecast the amount of ammunition it will use in combat operations. Enabling technologies of the weapons systems studied have led to a remarkable reduction in ammunition consumption in all combat operations. These weapon systems include the M1 Abrams main battle tank, M2 Bradley infantry fighting vehicle, AH-64 Apache attack helicopter, and multiple-launch rocket system. The technologies have greatly increased accuracy, precision munitions, survivability, and lethality. Additionally, this study describes how a shaping operation by Air Force, Navy, and multiple-launch rocket system also reduces the amount of ammunition used in combat operations. Historical data from World War II, Operation Desert Storm, and Operation Iraqi Freedom were used as part of the research tool to develop the argument and disprove the theory. The research proves that Field Manual 101-10-1/2 calculations for ammunition consumption are very high and not relevant for today's battlefield. Additionally, it provides information that historically planners have overestimated the amount of ammunition that will be used for an operation. Recommendations for future projects of this nature are made.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**1**	**76**	

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

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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

A STUDY OF AMMUNITION CONSUMPTION, by Major William K. Freeman Jr., 76 pages.

The purpose of this research was to investigate the United States Army's ability to correctly estimate and forecast the amount of ammunition it will use in combat operations. Enabling technologies of the weapons systems studied have led to a remarkable reduction in ammunition consumption in all combat operations. These weapon systems include the M1 Abrams main battle tank, M2 Bradley infantry fighting vehicle, AH-64 Apache attack helicopter, and multiple-launch rocket system. The technologies have greatly increased accuracy, precision munitions, survivability, and lethality. Additionally, this study describes how a shaping operation by Air Force, Navy, and multiple-launch rocket system also reduces the amount of ammunition used in combat operations. Historical data from World War II, Operation Desert Storm, and Operation Iraqi Freedom were used as part of the research tool to develop the argument and disprove the theory. The research proves that Field Manual 101-10-1/2 calculations for ammunition consumption are very high and not relevant for today's battlefield. Additionally, it provides information that historically planners have overestimated the amount of ammunition that will be used for an operation. Recommendations for future projects of this nature are made.

ACKNOWLEDGMENTS

Special thanks to the following people for their assistance in preparing and completing this project:

- First of all to God as my initial motivation to begin the MMAS program

- Dr. Ronald E. Cuny for his encouragement and direction

- Associate Professor James B. Martin for committing his time as my Committee Chair

- LTC Timothy McKane for his commitment, advice and combat stories

- LTC David Beachum for his faith in my abilities

- LTC Jerry L. Wood for mentorship and motivation to complete this project

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ACRONYMS

Acft	Aircraft
AHR	Attack Helicopter Regiment
DOD	Department of Defense
IFV	Infantry Fighting Vehicle
MLRS	Multiple-Launch Rocket System
TIS	Thermal Imaging Systems
TOW	Tube Lunched, Optically Tracked, Wire Guided

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CHAPTER 1

INTRODUCTION

Purpose

> During the opening days of Operation Iraqi Freedom, the 3-7 Cavalry Squadron was low on ammunition. One possibility for this could have been the use of out-dated references to calculate ammunition consumption. (2003)
>
> 3rd Infantry Division

This thesis explored the logistical doctrine of ammunition consumption and modern warfare. Specifically, the focus was the ammunition consumption rate in a training environment versus a combat operation and how the calculations for ammunition consumption relate to the method used by the military to calculate the amount of ammunition needed for any operation. An assumption can be made that the military uses the same ammunition calculation method in training that it uses in combat; in essence, the concept of "train as you fight." The principal thrust of this thesis question was to determine whether planners overestimate the amount of ammunition that will be used in operations, be it training or combat.

Background

The focus of this thesis stemmed from discussion during Command General Staff Officer Course classes regarding the amount of ammunition used in combat and the planning process to forecast ammunition consumption. Conversations often developed into heated debate. The researcher disagreed with the logistician students and argued that the methods of calculation were antiquated and probably used data from the World War II era. Logisticians argued that current doctrine regarding wartime ammunition

consumption was based on a book called “Big Bertha,” Field Manual 101-10-1/2, *Staff Officers’ Field Manual Organizational, Technical, and Logistical Data Planning Factors*. However, the researcher later discovered that FM 101-10-1/2 used World War II data. This may be significant for two reasons. First, the technological advances in weapons systems lethality may reduce the rate of ammunition consumed. The second reason is that the United States has no current “real-world” data on ammunition consumption in defensive operations, because the military has not been in a defensive posture since Vietnam or Korea. Further, the United States military is structured for offensive not defensive operations. Therefore, the research may also show that the military may only need one table that forecasts ammunition consumption.

Importance

The importance of this research is that it may provide information that impacts current logistical doctrine. As a result of the research, the Army may want to modify the way it uses an ammunition calculation schedule which has its origin based on World War II data. The Army needs to create a new ammunition calculation schedule with current statistics. The researcher believes that by providing current, accurate data, Field Manual 101-10-1/2, *Staff Officers’ Field Manual Organizational, Technical, and Logistical Data Planning Factors,* may be restructured to use current statistics, thus making it more relevant. The date of the most current copy of this field manual is 1990. The researcher also compared the tables in the 1990 edition to the tables in a previous edition and did not find any changes. Additionally, the research provides data that shows the Logistical Estimate Worksheet also calculates ammunition consumption at a very inflated rate.

It is important to be accurate in calculating actual ammunition requirements. The act of moving and storing large amounts of ammunition requires vital logistics assets. These logistical assets are far more effective and efficient moving critical supplies and equipment than ammunition that exceeds mission requirements. This also includes maritime transportation assets. The use of transportation more effectively will act as a combat multiplier and enable the Army to make more efficient use of limited transportation assets. Having more flexibility to transport the right amount of the right class of supply is the multiplier. The second and third order effects of calculating ammunition consumption at a higher rate than necessary are that other classes of supply are adversely affected when it is time to move the ammunition. Transportation is a finite commodity in combat, not only the common user land transportation but also ships at sea.

Primary Question

In modern warfare, utilizing current equipment, does the United States Army correctly forecast the amount of ammunition it will use in combat operations?

Secondary Questions

1. How much ammunition was consumed by VII Corps and XVIII Corps during the ground operations of Operation Desert Storm?

2. How much ammunition was forecast in Operation Desert Storm?

3. What method was used to forecast the ammunition in Operation Desert Storm?

4. How much ammunition was consumed by V Corps during the first twenty-one days of Operation Iraqi Freedom (major combat operations)?

5. How much ammunition was forecast in Operation Iraqi Freedom?

6. What method was used to forecast the ammunition in Operation Iraqi Freedom?

Assumptions

1. That an offensive unit meets the doctrinal criteria of a one-to-three ratio in defensive operations and a three-to-one ratio in offensive operations. This assumption provides a baseline to accurately determine the number of combat systems participating in each operation.

2. That Battle Command Training Program controllers have not altered ammunition resupply. In warfighter exercises the system controllers have the ability to "magic" ammunition resupply.

3. The planners, for ammunition consumption, in Operation Desert Storm used Field Manual 101-10-1/2, and the VII Corps planners used the G4 battle book. The G4 battle book used data from Field Manual 101-10-1/2. Additionally, planners for Operation Iraqi Freedom used the Logistics Estimate Worksheet.

Study Limitations

1. Data: Several limitations and biases in the data underlying these assessments should be considered when reviewing the following analyses. Much of the available data remains uncompiled and not analyzed.

a. Data compilation and analysis for Operation Iraqi Freedom is likely to take several more years. This study used only data currently available, a fraction of what may ultimately be accumulated.

b. Some important data were not collected. Comprehensive battle damage assessment data do not exist for Operation Desert Storm or Operation Iraqi Freedom. It is

difficult to assess weapon effectiveness without detailed data on what targets were damaged, to what extent, and by which systems.

c. Even when battle damage assessment is available, it can be difficult to associate with a specific weapon. Many targets were hit with several weapons of the same type or with several different types of weapons or both. In most cases, it is impossible to be sure which weapons did what damage. Effectiveness of individual weapons cannot be determined, except that all United States weapons systems are powerful enough to destroy and or disable most any enemy equipment.

2. Resources

a. Battle Command Training Program

(1) The data from the Battle Command Training Program is from one rotation. The researcher used information gathered from the 49th Armor Division.

(2) Battle Command Training Program memorandum of agreements with participating units established constraints on numbers and types of ammunition that can be used during a five-day training exercise. One of the constraints is the number of Army Tactical Missile System rounds (60) given to the unit in resupply. Additionally, there is a constraint put on the number of Hellfire missiles allowed for AH-64 Attack Helicopters.

b. The information from the National Training Center, Commander of Operations Group, After-Action Review, Live-Fire Stats, is an average for ten rotations from the live-fire portion of the rotation. Additionally, the National Training Center information will not cover multiple-launch rocket systems (MLRS) or AH-64 weapon systems. MLRS does not participate at the National Training Center because of the operational echelon and doctrinal distances normally associated with division and corps level

operations. Because of safety considerations, AH-64 attack helicopters do not participate in the combined arms live fire at the National Training Center.

3. New Equipment: The researcher chose to limit the research from Operation Desert Storm to present. The purpose of this decision was to use all-modern equipment in the study. It was determined that the use of a broader equipment base that included the Korean and Vietnam war eras would skew the significance of the research.

4. Shaping by Navy and Air Force: Shaping operations conducted by the Navy and the Air Force are not factored into this study.

5. Summary: This research covers modern war--post-Vietnam--specifically Desert Storm to present. The reasoning behind that decision is because information prior to Desert Storm is not applicable in modern war--due to technological advances.

Delimitations

The researcher has limited this study to the following combat systems:

1. M1 Abrams Tank--The use of 120-millimeter main gun rounds (Sabot and high- explosive antitank).

2. M2/3 Bradley Infantry Fighting Vehicle--The use of tube-launched, optically tracked, wire-guided (TOW) missiles and 25-millimeter chain-gun rounds.

3. AH-64 Attack Helicopter--The use of Hellfire missiles, 2.75-inch hydra rockets, and 30-millimeter chain-gun rounds.

4. Multiple-Launch Rocket System--The use of M77 rockets and Army tactical missile system.

5. The researcher only counted the rounds fired as being consumed. Destroyed, lost, or redistributed ammunition are not counted as "consumed" for the purpose of this study.

6. The Battle Command Training Program Corps level data is not reliable; therefore, it is not used in this study.

Definitions of Terms

AH 64 Attack Helicopter. Figure 1 is a photograph of the Army's AH64 helicopter, the primary antiarmor attack helicopter. The AH-64 weapons systems include Hellfire missiles, 2.75-inch Hydra rockets, and 30-millimeter chain gun (Stuttman 1991, 1120). The AH 64 is an airborne weapons system that is designed to destroy, disrupt, or delay enemy forces in either the close fight or deep attack. The Apache helicopter can fight and survive during the day, night, and adverse weather throughout the world. The AH 64 has the primary mission to destroy high-value or payoff targets with the Hellfire missiles. The Apache helicopter is also capable of using the 30-millimeter chain gun and 2.75-inch Hydra rockets that are lethal against a wide variety of targets.

> It is a quick-reacting, airborne weapon system that can fight close and deep to destroy, disrupt, or delay enemy forces. The Apache is designed to fight and survive during the day, night, and in adverse weather throughout the world. The principal mission of the Apache is the destruction of high-value targets with the Hellfire missile. It is also capable of employing a 30MM M230 chain gun and Hydra 70 (2.75 inch) rockets that are lethal against a wide variety of targets. (Military Analysis Network 2005)

Figure 1. AH 64 Attack Helicopter
Source: AH 64 Attack Helicopter, Redstone Arsenal Aviation History Photo, Redstone Arsenal, AL, 1984 [The US Army's Official Aviation History Web Site]; available from http://www.redstone.army. mil/history/aviation/ah-64/ah-640002.html; Internet; accessed on 6 September 2004.

Battle Command Training Program (BCTP). A program that conducts simulation warfighter exercises conducted to train division and corps-sized staffs.

> BCTP is composed of four Operations Groups (A, B, C, and D) as well as a Headquarters, and the World Class Opposition Forces. Each Operations Group is commanded by a colonel (Commander, Operations Group or COG) and has a unique mission. Operations Groups A and B focus primarily on division and corps warfighter exercises. These two Operations Groups have a combined capability to conduct fourteen division warfighter exercises per year. A corps warfighter exercise equals two division warfighter exercises, as both Operations Groups are required. They also conduct seminars, mission rehearsal exercises, and advanced decision-making exercises for units deploying in support of peacekeeping operations. Operations Group C focuses on training National Guard brigades and the Army's new Initial Brigade; and it conducts fourteen brigade rotations per year. (Battle Command Training Program 2005)

M1 Abrams Tank. Figure 2 is a full-tracked, armored combat vehicle capable of sustained offensive and defensive combat. It is designed to close with and destroy enemy forces using shock action, firepower, and mobility in coordination with supporting ground and air systems under all battlefield conditions. The M1's main weapon is the

120-millimeter smooth-bore main gun (Stuttman 1991, 149). “The purpose of this vehicle is to provide mobile firepower for armored formations of sufficient capability to successfully close with and destroy any opposing armored fighting vehicle in the world, while providing protection for its crew in any conceivable combat environment. It is capable of engaging the enemy in any weather, day or night on the multidimensional, nonlinear battlefield using its firepower, maneuver, and shock effect” (Military Analysis Network 2005).

Figure 2. M1 Abrams Tank
Source: Military Armor Fotogallery, Fort Irwin, California, 1999. [Military Analysis Network Web Site]; available from http://www.fas.org/man/dod-101/sys/land/m1.htm; Internet; accessed on 6 September 2004.

M2/3 Bradley Infantry Fighting Vehicle. The Bradley infantry fighting vehicle (figure 3) provides mechanized infantry, armored cavalry, and scout units with a full-tracked, lightly armored, fighting vehicle with the mobility, lethality, and survivability to operate with the M1 Abrams tank as a member of the combined arms team. The Bradley’s weapons systems are the TOW missile and the 25-millimeter Bushmaster chaingun. For the purpose of this research, both variants were combined in one group. The differences between the two variants have no significance to this study (Stuttman 1991, 40).

Figure 3. M2/3 Bradley Infantry Fighting Vehicle
Source: Department of Defense Land System Photo, Fort Hood, Texas, 2000. [Federation of American Scientist Web Site]; available from http://fas.org/man/dod-101/sys/land/m2.html; Internet; accessed on 6 September 2004. Internet; accessed on 6 September 2004.

Modern War. For the purpose of this research, modern war is defined as the post-Vietnam War era.

Multiple-Launch Rocket System (MLRS). Figure 4 contains photographs of a long-range, free-flight rocket system that provides general support artillery fires to division and corps level tactical units. Note: During Operation Desert Storm and Operation Iraqi Freedom, two different types of MLRS munitions were used, the M77 rocket and Army tactical missile system (Stuttman 1991, 881). The MLRS provides the Army an all-weather, indirect, area fire weapon system to strike counterfire, air defense, armored formations, and other high-payoff targets at all depths of the tactical battlefield. Primary missions of MLRS include the suppression, neutralization, and destruction of threat fire support and forward-area air defense targets.

The MLRS is a versatile weapon system that supplements traditional cannon artillery fires by delivering large volumes of firepower in a short time against critical, time-sensitive targets. These targets often include enemy artillery, air defense systems,

mechanized units, and personnel. MLRS units can use their system's "shoot-and-scoot" capability to survive while providing fire support for attacking maneuver elements. MLRS is not intended to replace cannon artillery, but has been designed to complement it (Military Analysis Network 2005).

Figure 4. Multiple-Launch Rocket System
Sources: Photos from left to right: Aeronautics Ballistics Archive, Redstone Arsenal History Photo; Redstone Arsenal History Photo; Redstone Arsenal Public Affairs Photo; and Department of Defense Land Systems Photo, Whitesands Missile Range, New Mexico, 2000. [Defense Industry Daily Web Site]; available from http://images.search.yahoo.com; Internet; accessed on 6 September 2004.

National Training Center (NTC). A site where brigade-sized units conduct maneuver and live-fire training exercises. NTC trains the transformed Army by conducting force-on-force and live-fire training for ground and aviation brigades in a joint scenario across the spectrum of conflict, using a live-virtual-constructive training model, as portrayed by a highly lethal and capable opposing force and controlled by an expert and experienced Operations Group (Global Security 2005).

The background, purpose, importance, assumptions, and terminology of this thesis set the stage for arguably the most critical sections of this research, the references and data used to support analysis, arrive at findings, draw conclusions, and make

recommendations. Chapter 2 of this thesis contains the author's endeavors to review the literature associated with ammunition forecasting and consumption.

CHAPTER 2

LITERATURE REVIEW

> A soldier in combat can go a year without pay; months without mail; days without food, water, and sleep; but he cannot survive a minute without ammunition. (Helfast XVII Conference fall 1986)
>
> LTG Joseph M. Heiser

Introduction

This study used after-action reports and historical data from Operation Desert Storm, Operation Iraqi Freedom, the Battle Command Training Program, and the National Training Center. This chapter reviews data and literature that surrounds the topic of the secondary questions, in order to answer the primary research question about the ammunition calculation located within Army doctrine. This chapter also examined other factors found, such as survivability, shaping operations conducted by the Air Force and Navy, the use of MLRS, and the Army's AH-64 attack helicopters, in shaping operations prior to ground combat in Operation Desert Storm.

The battle space that a division occupied in World War II was10 kilometers wide and 40 kilometers deep. This has been greatly expanded in today's Army. Today, a division can occupy a width of 100 kilometers and a depth of 240 kilometers. The modern division today can occupy a front ten times what a division in World War II could cover. Additionally, the depth is six times greater today than in World War II.

The percentage of kill ratio in World War II is compared with today's Army. In World War II it was a ratio of 14 to 1. It took fourteen rounds of ammunition to kill an armored vehicle. The historical data table (table 1) illustrates that the average range of

those hits would have had to be closer than 800 meters. The percentage of kill ratio in Operation Desert Storm was 1.2 to 1. It took a little more than one round of ammunition to kill an armored vehicle and the average range was 2,200 meters.

Table 1. Historical Comparison from World War II and Operation Desert Storm

	World War II	Operation Desert Storm
Width	Division 10KM	Division 100KM
Depth	Division 40KM	Division 240KM
Percentage Kill	14:1 @ 800m	1.2:1 @ 2200m

Source: Scales 1999, 3.

The comparison indicates that it would take 12 more rounds of ammunition in World War II to kill an armored vehicle than in Operation Desert Storm. Also, the vehicles would have to be 1,400 meters closer than in Operation Desert Storm. The battle space is almost two times closer than the distance modern weapons need to kill an enemy vehicle. The comparison is unprecedented. This suggests the modern Army needs only 8 percent of the tank ammunition that the Army of World War II used.

Field Manual (FM) 4-30.1, *Munitions Distribution in the Theater of Operations,* states, "A review of United States Army involvement in recent operations clearly indicates the need to improve logistical planning. Plans must be developed to support all levels of combat operations and stability and support operations. It is critical that Class V support planning be detailed and threat-based" (Department of the Army 2003, 4-1).

"The objective of the ammunition distribution system is to provide ammunition at the right time, place and quantity to ensure the success of an operation. They must complement combat plans and operation, and improve the ability of the supported unit to

accomplish its mission. The supported commander's concept of operations, priorities and allocations dictate the actions of the ammunition planner" (Department of the Army 2003, 4-1).

Ammunition consists of bullets, rockets, demolitions, mines, missiles, artillery, tank, and associated munitions. Ammunitions supply is based on a required supply rate and controlled supply rate. The required supply rate is the estimated amount of ammunition required to sustain operations, without restrictions, for a specific period. The rate is determined by forecasting ammunition requirements based on the mission, enemy, troops, terrain, and time available. The required supply rate is based upon weapon density for a given unit. Required supply rates can be developed by several methods, but the accuracy of the calculations varies from method to method. The controlled supply rate is the rate of ammunition that can be supported for a given period based on ammunition availability. If a support unit cannot supply a specific type of ammunition based on the forecasted required supply rate, then it imposes a controlled supply rate to limit the distribution of that type of ammunition. The controlled supply rate may be less than the required supply rate: the optimum situation is when the required supply rate equals or is less than the controlled supply rate (Department of the Army 2001, 1-4).

A combat load is the ammunition required by each combat system and the individuals assigned to that system. Also called the minimum initial issue quantity, a combat load is a standard measure used throughout the Army and provides the baseline upon which units develop their basic loads. Class V loads can be calculated per system, per individual, or per unit (Department of the Army 2001, 1-4).

Basic load is the command-determined quantity and type of munitions carried by an individual, unit, or combat system. A unit basic load is the amount of ammunition needed to initiate combat operations and can be moved in a single load by a designated unit for a particular mission (Department of the Army 2001, 1-4).

Lethality

The lethality of modern United States weapon systems may also reduce the need for large stockpiles of ammunition.

The M2 Bradley was upgraded after Desert Storm to increase its lethality. The laser range finder was one of the enhancements to increase effectiveness. “The addition of PGS/POSNAV enhances the Bradley’s ability to maneuver with the rest of the combined arms team. The integration of Global Positioning System with the laser range finder allows rapid, accurate calls for fire” (22nd Support Command 1992, 225). Finally, the addition of Force XXI Battle Command Brigade and Below command and control capability provided a near real-time integrated data link between the Bradley fighting vehicle and other combat vehicles. The Force XXI Battle Command Brigade and Below capability, integrated with the laser range finder of the Bradley and the crew’s ability to identify and hand off targets to other Bradley fighting vehicles, tanks, or helicopters, has also increased the weapon system’s lethality.

The capability of the TOW missile is good with the exception that it is wire guided and has a long flight time. However, the lethality of the TOW missile is excellent.

> The lethality of the TOW missile was proven beyond doubt during Desert Storm when one of the TOW missiles fired by US troops went right through the tank it was aimed at and penetrated another tank parked next to it. Another TOW went through a six-foot dirt berm and knocked out an Iraqi armored personnel carrier

> on the other side. In both instances, the TOW performed a feat which it supposedly was incapable of accomplishing. (22nd Support Command 1992, 225)

The M1 Abrams tank is even more lethal than the Bradley.

> The capability of the M1 tank equipment, coupled with crew skill and training, enabled the M1 crews to 'see first, shoot first' resulting in many one-round kills on Iraqi armored vehicles. Thermal imaging systems (TIS) allowed detection of Iraqi targets day and night in smoke and haze at great distance. The Iraqi systems lacked this capability. Targets were routinely identified out to 1,500 meters and detected at much greater ranges with the median detection range of 2,600 meters. M1 crews were able to engage Iraqi tanks well beyond the range of Iraqi T-72s. (General Accounting Office 1992, 225)

Reports from enemy prisoners of war indicated they could only return fire at muzzle flashes. M1 units firing 120-millimeter, fin-stabilized, armor-piercing ammunition reported engaging and killing targets out to 3,500 meters (longest reported kill was 3,800 meters) with most engagements in the 2,000 to 2,500 meter range (General Accounting Office 1992). An Armor school report stated, "120-millimeter ammunition consistently achieved catastrophic kills against T-72 tanks, even when behind thick berms." An example of agility, mobility, and lethality of the M1 tank was demonstrated by the 2nd Brigade, 1st Armored Division, at the Battle of Medina Ridge. In a 45-minute battle, the unit achieved tactical surprise by moving quickly and silently and destroyed 100 Iraqi tanks and more than 30 BMPs. Finally, interviews with crews indicated many engagements occurred "on the move," 15 to 25 miles per hour, and involved engagements at all angles (22nd Support Command 1992, 225). After-action reports also indicated the M1 often outran all other United States battlefield systems.

Survivability

Studies of survivability conducted on Operation Desert Storm are available; however, Operation Iraqi Freedom studies are ongoing and are still classified.

> One of the most interesting modifications of the M1A1 series was the new armor composite including depleted uranium plate. This armor greatly increased resistance against kinetic energy rounds. During the Gulf War, M1A1 tanks could directly engage enemy tanks while in the enemy's line-of-sight with little risk from any eventual damage from incoming retaliatory fire. This means that M1A1 tanks could hit their targets, while Iraqi tanks couldn't hit, or, if they hit, couldn't damage M1A1 tanks. Also, due to depleted uranium armor, not a single US tank was penetrated from enemy fire. US tanks took many close direct hits from Iraqi Soviet-made T-72 and T-72M tanks, but enemy rounds were simply not able to penetrate the M1A1 tank's armor. (Department of Defense 1992)

Using the M1 Abrams survivability data from Operation Desert Storm, the research showed that survivability of this weapon system is significant in ammunition usage calculations. There was a low loss rate of M1 Abrams tanks in both Operation Desert Storm and Operation Iraqi Freedom. A low loss rate is a direct reflection of the survivability of the M1 Abrams tank. The ability to keep combat power in the fight allows momentum to remain at a high speed. Also, it gives the ability to expend the basic load, instead of re-arming the surviving tanks. Vehicle speed, agility, identification, engagement of enemy targets at very long distances, thermal imagery, armor protection, and employment all contribute to M1 survivability. Several sources reported impacts of enemy 125-millimeter armor-piercing ammunition on M1 Abrams without a single penetration in Operation Desert Storm. Additionally, there are six documented incidents of unidentified armor-piercing rounds striking, but failing to penetrate M1 Abrams tanks. Of eighteen combat incidents reported in Operation Desert Storm, nine of those were permanent losses (due to friendly fire). Damage on the other nine M1 Abrams was mostly from mines, and they were repairable at the organizational maintenance level (General Accounting Office 1992).

In Operation Iraqi Freedom there was a penetration of the M1 Abrams with an unknown weapon (the crew survived and the tank remained operational). Additionally,

there was one M1 Abrams destroyed by three antitank mines stacked on one another (notes taken by the researcher while serving as the V Corps LNO to Coalition Forces Land Component Command during Operation Iraqi Freedom).

The survivability described above is not consistent with the statistics routinely found in simulation at the Battle Command Training Program or with the Multi Integrated Laser Engagement System at the National Training Center (notes taken by the researcher while stationed at the National Training Center 1999-2002). Most battles conducted at the National Training Center are won by the opposing force. It is not uncommon for the opposing force to destroy over 70 percent of the Blue Forces equipment. This is not consistent with the statistics from Operation Desert Storm and Operation Iraqi Freedom, where less than 1 percent of the United States equipment was destroyed.

Logistical Data Requirements

The Field Manual 101-10-1/2, *Staff Officers' Field Manual Organizational, Technical, and Logistical Data Planning Factors*, lays out tables to calculate ammunition consumption for purposes of planning. The tables are broken down in the following manner: ammunition per type, per weapon, per day. Additionally, the tables go into more detail by illustrating the ammunition usage in Defense of Position and Attack of Position (deliberately organized). The planning factor in the defense is significantly higher than the planning factor in the offense.

The book *Moving Mountain: "Lessons in Leadership and Logistics from the Gulf War"* does not describe what the planners used to estimate the ammunition consumption for Operation Desert Storm. Therefore, the researcher is assuming that the planners used

Field Manual 101-10-1/2 and the G4 battle book that VII Corps used. The book does reference that the Army had sixty-five days worth of ammunition and that one days worth of ammunition weighed 9,000 tons. Another piece of valuable information that is described in the book is that the initial calculation of ammunition on hand was forty-five days worth of supply. After the combat was over, the Army recalculated the ammunition that was left, and the recalculated amount was sixty-five days worth of supply. What this is telling the researcher is that the method of the initial calculation was not correct. The equation would look like this: 45 – 4 = 65.

In preparation for Operation Iraqi Freedom, ammunition consumption was calculated by using the Logistical Estimate Worksheet. This worksheet has embedded formulas that determine the amount of ammunition consumed for a particular type of operation. The Logistical Estimate Worksheet was used as the starting point and then should have been staffed by the logistical planners and put to the common sense test, where experience, history, and the enemy was factored into the process.

Table 2 illustrates the difference between calculations for offense and defense using the methods from Field Manual 101-10-1/2. It also shows a percentage difference.

Table 2. Ammunition Usage Rates for Defense and Offense from FM 101-10-1/2

	Ammo Type	Rounds in Defense	Rounds in Offense
M1 Abrams 1st Day	120mm	37 per Tank	16 per Tank
M1 Abrams Succeeding Days	120mm	22 per Tank	9 per Tank
M2 Bradley 1st Day	TOW	6 per ITV	5 per ITV
M2 Bradley Succeeding Days	TOW	7 per ITV	6 per ITV
M2 Bradley 1st Day	25mm	214 per ITV	174 per ITV
M2 Bradley Succeeding Days	25mm	167 per ITV	129 per ITV
MLRS 1st Day	Rocket	99 per MLRS	75 per MLRS
MLRS Succeeding Days	Rocket	98 per MLRS	76 per MLRS
AH 64 Apache 1st Day	Hellfire Missile	16 per Acft	12 per Acft
AH 64 Apache Succeeding Days	Hellfire Missile	17 per Acft	13 per Acft
AH 64 Apache 1st Day	2.75 Inch Rockets	26 per Acft	21 per Acft
AH 64 Apache Succeeding Days	2.75 Inch Rockets	15 per Acft	12 per Acft
AH 64 Apache 1st Day	30mm	770 per Acft	628 per Acft
AH 64 Apache Succeeding Days	30mm	602 per Acft	463 per Acft

Source: Department of the Army, FM 101-10-1/2, *Staff Officers' Field Manual Organizational, Technical, and Logistical Data Planning Factors* (Washington, DC: Department of the Army Headquarters, 1990), 2-129-136.

It is very important that the Army considers the amount of ammunition really needed to conduct effective combat operations. The literature data illustrates that the amount of ammunition needed for today's battlefield appears to be much less than previous wars. The reports suggest lethality and survivability are factors influencing the amount of ammunition needed for combat. The amount of combat power lost reduces the ability to kill the enemy. Therefore, survivability of weapon systems keeps weapon systems on the battlefield and gives the unit more ability to kill. Additionally, the lethality of a weapon system reduces the ammunition needed especially for one-shot, one catastrophic kills. If modern combat uses less ammunition, then this may influence the number of transportation assets used to move ammunition around the battlefield, which would free transportation assets to move other classes of supply, such as water, food, and materials.

CHAPTER 3

METHODOLOGY

The primary research question was: In modern warfare, utilizing current equipment, does the United States Army correctly forecast the amount of ammunition it will use in combat operations?

In this methodology, tables of ammunition usage were created to compare and analyze usage for Operation Desert Storm, Operation Iraqi Freedom, the Battle Command Training Program, and the National Training Center. The types of ammunition included in the tables were for the M1 tank, M2 Infantry fighting vehicle, MLRS, and AH64 attack helicopter.

Tables were created to show how many weapons systems participated in Operation Desert Storm and Operation Iraqi Freedom. Additionally, a table showed how many weapons participated in simulations at the Battle Command Training Program and the number of weapons systems that participate at the National Training Center.

The first step was to record in the tables (see sample tables 2 through 11) the amount of ammunitions used in actual combat. Then the same information was gathered and recorded from simulations. Finally, the data from the National Training Center live-fire results were incorporated into the appropriate table to bridge the gap from offense combat operations to a controlled live-fire defensive operation for any future study.

The final step was to calculate the percentage of ammunition used from the amount of ammunition on hand. These calculations could then be used to determine the amount of ammunition available to continue combat operations.

The mathematical equation is C divided by H equals U, where C is equal to the amount of ammunition consumed, H is equal to the amount of ammunition on hand at the beginning of the exercise or operation, and U is equal to the percentage of ammunition used.

Once the percentage of ammunition has been determined, it can be used to compare to the test data from the National Training Center. Additionally, when all the calculations are completed the data can be compared from actual usage on the ground as rounds per weapon system, per day to the references that are used to forecast ammunition. This last calculation will be the total number of rounds fired from each particular weapon system divided by the number of weapon system in that operation and then divided by the number of days of the operation. This will enable one to answer the primary research question: in modern warfare, utilizing current equipment, does the United States Army correctly forecast the amount of ammunition it will use in combat operations?

The National Training Center provides additional data and serves as the link between offensive and defensive operations for any future studies. Also, any anomalies are explained to make the data useful. These results were then applied to Operation Desert Storm and Operation Iraqi Freedom. By using the percentage of combat systems conducting operations and the amount of ammunition used in maneuver, a generalization will be reached that will address the primary research question.

Table 3. Number of Combat Systems That Participate in Test Base in Each Area of Study (blank table for methodology)				
Weapon System	M1 Abrams	M2/3 Bradley	AH-64	MLRS
Desert Storm				
OIF (V Corps)				
BCTP Corps				
BCTP Division				
NTC BDE				

Table 4. Ammunition Usage for Operation Desert Storm (blank table for methodology)				
Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS				
120-millimeter Rounds				
TOW Missiles				
25-millimeter Rounds				
Hellfire Missiles				
2.75-inch Rockets				
30-millimeter Rounds				

Table 5. Ammunition Usage for Operation Iraqi Freedom
(blank table for methodology)

Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS				
120-millimeter Rounds				
TOW Missiles				
25-millimeter Rounds				
Hellfire Missiles				
2.75-inch Rockets				
30-millimeter Rounds				

Table 6. Ammunition Usage for Division Warfighter Exercise
(blank table for methodology)

Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS				
120-millimeter Rounds				
TOW Missiles				
25-millimeter Rounds				
Hellfire Missiles				
2.75-inch Rockets				
30-millimeter Rounds				

Table 7. Ammunition Usage for National Training Center Brigade (blank table for methodology)

Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS				
120-millimeter Rounds				
TOW Missiles				
25-millimeter Rounds				
Hellfire Missiles				
2.75-inch Rockets				
30-millimeter Rounds				

Table 8. Average Number of Targets Presented at the National Training Center (blank table for methodology)

Target Type	Offense	Defense	Remarks
T80 Tanks			
BMPs			
Dismounts			

Table 9. Average Number of Rounds Fired at the National Training Center (blank table for methodology)

Ammunition	Offense	Defense	Remarks
120-millimeter Rounds			
25-millimeter Rounds			
TOW Missiles			

Table 10. Average Number of Systems Participating at the National Training Center (blank table for methodology)			
Type of System	Offense	Defense	Remarks
M1 Abrams Tank			
M2 Bradley IFV			

Table 11. Basic Combat Load Amounts and Total Ammunition on Hand (blank table for methodology)				
	M1 Basic Load / Total in Theater	M2 Basic Load / Total in Theater	AH-64 Basic Load / Total in Theater	MLRS Basic Load / Total in Theater
Operation Desert Storm				
Operation Iraqi Freedom				
BCTP Division Exercise				
NTC BDE Live-Fire Exercise				

CHAPTER 4

ANALYSIS

This chapter takes the data gathered in the literature review to answer the primary research question: In modern warfare, utilizing current equipment, does the United States Army correctly forecast the amount of ammunition it will use in combat operations?

Secondary Questions

1. How much ammunition was consumed by VII Corps and XVIII Corps during the ground operations of Operation Desert Storm? This answer is illustrated in table 12.

Table 12. Total of All Ammunition Used in Operation Desert Storm

M1 120mm	M2 25mm	M2 TOW	MLRS	AH-64 Hellfire	AH-64 Rockets	AH-64 30mm
14,061	165,295	964	6,604	843	2,035	28,621

2. How much ammunition was consumed by V Corps during the first 21 days of Operation Iraqi Freedom? (Major Combat Operations) This answer is illustrated in table 13.

Table 13. Total of All Ammunition Used in Operation Iraqi Freedom

M1 120mm	M2 25mm	M2 TOW	MLRS	AH-64 Hellfire	AH-64 Rockets	AH-64 30mm
1,576	16,026	375	548	462	1,338	12,057

3. How much ammunition was consumed during a Division Warfighter Exercise?

This answer is illustrated in table 14.

Table 14. Amount of Ammunition Used in Division Warfighter Exercise						
M1 120mm	M2 25mm	M2 TOW	MLRS	AH-64 Hellfire	AH-64 Rockets	AH-64 30mm
N/A	N/A	N/A	125	1,102	2,480	6,174

4. Is more ammunition consumed during live-fire operations at the National Training Center during offense or during defense? No, the same amount of ammunition is used in the offense and the defense for all weapon systems, as illustrated in table 15.

Table 15. Average Amount of 120-millimeter Rounds Fired in Offense and Defense at the National Training Center During Live Fire			
M1 Abrams Tank	Offense	Defense	Remarks
Number of rounds fired per Tank	11	10	The difference of one is not statistically significant

Table 16 describes the number and type of weapon systems used in the following areas: Operation Desert Storm, Operation Iraqi Freedom, Battle Command Training Program Corps warfighter exercises, Battle Command Training Program Division warfighter exercises, and the National Training Center Brigade live-fire exercises. Additionally, the researcher must calculate the number of basic combat loads needed to outfit all the weapon systems studied, then compare that number with the amount of basic combat loads of ammunition on hand for the operation. The table lists all combat systems studied in each operation or exercise. This data determined the average amount of ammunition used by each system and how near that number was to the basic combat load of that particular weapon system.

The number of weapon systems used in Operation Desert Storm is significantly higher than the number used in the recent Operation Iraqi Freedom. One of the reasons for this is that in 1990 the Iraqi Army was the fourth largest army in the world. Additionally, the Army had not used the new generation of weapon systems in major combat operations and did not know what type of results it would obtain would obtain.

Table 16. Number of Combat Systems That Participate in Test Base in Each Area of Study

Weapon System	M1 Abrams	M2/3 Bradley	AH-64	MLRS
Desert Storm	1178	2200	274	189
OIF (V Corps)	222	312	153	99
BCTP Division	178	224	18	18
NTC BDE	44	90	18	N/A

Analysis

Table 17 describes how much ammunition was on hand at the beginning of Operation Desert Storm, for each system studied. The table also shows the amount of ammunition consumed during the 100-hour ground attack. The final part of the table is the percentage of ammunition that was used of the total on hand.

Ammunition Usage for Operation Desert Storm

How much ammunition did VII Corps and XVIII Corps consume during the ground operations of Operation Desert Storm?

Table 17. Ammunition Usage for Operation Desert Storm				
Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS	17,145	6,604	39%	1.4
120-millimeter Rounds	206,075	14,061	7%	2.98
TOW Missiles	18,564	964	5%	.11
25-millimeter Rounds	3,694,255	165,295	4%	18.74
Hellfire Missiles	11,516	843	7%	.77
2.75-inch Rockets	52,319	2035	4%	1.86
30-millimeter Rounds	586,652	28,621	5%	26.11

NOTE: Calculations were typically 60 percent up to 90 percent higher. The researcher has the understanding that there should be a reserve of ammunition for continued operations.

This research shows that the ammunition consumption rate was much lower than anticipated. Additionally, the transportation assets required to move the daily ammunition was reported as 450 trucks in the 22nd Support Command After-Action Report. If the ammunition usage rate was lower than expected, then transportation assets required to move that ammunition could be lowered as well. Therefore it is imperative that the correct method is used to calculate ammunition consumption rates. For example, using the median percentage of the ammunition used for all the weapon systems studied--that number is 22 percent, it can be deduced that it would have only taken as few as 22 percent of the trucks to move the required ammunition. Therefore, the 450 trucks used to transport ammunition could have been reduced by 78 percent or 349 trucks. Those transportation assets would then have been available to transport other classes of supply and critical items, such as water and mission oriented protective posture suits.

The example above is only valid if all ammunition was equally distributed among the transportation assets and if all the types of ammunition in this study were the same weight and required the same cubic space per unit of ammunition. Therefore, the example above is a dramatic leap to illustrate the point. But, the data clearly supports that there would be a waste of transportation assets. The data just cannot narrow down the exact amount of transportation assets without more extensive research.

There is an extensive report that covers supplies during the Desert Shield and Desert Storm operations. The 22nd Support Command After-Action Report covers the buildup and use of all classes of supply for Desert Shield and Desert Storm. An after-action review suggests that the logisticians grossly overestimated the amount of ammunition needed to conduct operations. “On G-Day there were approximately 45 days of Class V on hand (much was stocked over the 100 percent required). By the cease-fire, 28 February, there was approximately 66 days of supply in Class V based on the usage level during the 100 hours ground war” (22 Support Command After-Action Report 1992, 2:4). This is stating that the calculation began with forty-five days of supply--then they fought the ground war for four days and consumed ammunition for those four days. Finally, they recalculated the amount of ammunition left over using the usage rates from the 100 hours of the war. After the recalculation was completed, there was enough ammunition on hand to conduct the war for sixty-six more days at that rate. This information led the researcher to believe that the original factor used to compute the calculation was very high.

The phenomenon of the increase in number of days of supply is caused by the forecast of the amount of ammunition. The root of the issue is the number of rounds

forecast as per round, per tube, per day. For instance, if the number that should be forecast should be .33 and the forecaster rounds up to one, the result will be two-thirds too much. This is not a real problem if the forecast is for one tube. However, if the forecaster rounds up as methodology for all ammunition and weapon systems in theater, the results are tremendous. That "hand wave" within the logistics system will overstress the transportation system needed to move the ammunition.

Operation Iraqi Freedom

Research discovered comparisons between Operation Desert Storm and Operation Iraqi Freedom. Some of the topics included number of allied troops, enemy troops, friendly vehicles, enemy vehicles destroyed, and distance traveled during combat. Additionally, the amount of ammunition consumed in major combat operations was very interesting: four days as compared to twenty-one days. The phenomenon of using less ammunition over a longer duration may be attributed to precision munitions, lethality of the rounds and fewer combat systems to consume ammunition. Of course, there is no way to guess how long a conflict will last; there are just too many factors involved (will to fight, how will the enemy fight, luck, etc.). Reports also show that during Operation Desert Storm the Army had more combat equipment than during Operation Iraqi Freedom (Tame 2004).

In Desert Storm there were over 950,000 coalition forces serving, whereas there were only 350,000 coalition forces serving in Operation Iraqi Freedom during major combat operations. The size of the Republican Guard was significantly reduced from 150,000 in Desert Storm to 80,000 in Operation Iraqi Freedom. Additionally, the numbers for coalition tanks, armored personnel carriers, and artillery pieces for Desert

Storm were: 5,000 tanks, 5,000 armored personnel carriers, and 3,000 artillery pieces--compared to 2,200 tanks, 2,400 armored personnel carriers, and only 400 artillery pieces in Operation Iraqi Freedom. Finally, in the four days of ground combat in Operation Desert Storm the coalition forces traveled 250 miles and destroyed 3,800 tanks and 1,450 armored personnel carriers. While in the twenty-one days of major combat operations of Operation Iraqi Freedom the coalition forces destroyed 847 tanks and 777 armored personnel carriers (Tame 2004).

Lethality during Operation Iraqi Freedom was greatly improved in comparison to the lethality in Operation Desert Storm. Over the past twelve years, technological advances in training, equipment, and the integration of new systems have improved lethality. The ability to integrate all combat systems has been accomplished by using the Force XXI Battle Command Brigade and Below command and control system. Additionally, during Operation Iraqi Freedom the Army began using C2PC (command and control personal computer) in conjunction with Blue Force tracker. This allows the full integration of combat systems, which in turn makes the military more lethal. The individual systems may have improved in lethality, but the ability to synchronize the systems on the battlefield improved the lethality even more.

The significance of table 17 is twofold--first and most obvious is that the percentage of ammunition used is incredibly low. Additionally, the amount of ammunition on hand was less than it was in Operation Desert Storm for MLRS: 120-millimeter rounds, TOW missiles, and 25-millimeter rounds. That should be the case, because there were more weapon systems involved in Operation Desert Storm. However, the amount of ammunition is significantly higher for the AH-64 attack helicopter in

Operation Iraqi Freedom--with almost one-half the number of attack helicopters. The reason behind this could be that the Army's training centers concentrated very heavily on the deep attack using attack aviation.

If it took 450 trucks to move an estimated day's supply of ammunition, it is a fact that it would take less trucks to move ammunition in Operation Iraqi Freedom. It could be up to one-half as many trucks during Operation Iraqi Freedom or 225 trucks. It also can be calculated that if the Army only used about 6 percent of the estimated ammunition in Operation Iraqi Freedom, then the Army would have only needed to use a lower amount of transportation assets to conduct ammunition resupply, maybe even as low as fifteen trucks to move that ammunition. Therefore the other 210 trucks a day could have moved other important sustainment items or could have been used in preparation for stability operations. Two things that the researcher knows that could have been moved--one is small arms ammunition, while the second is potable water. This would support the statement made by LTG William S. Wallace, who said, "This is not the enemy we war gamed against." (Freeman 2003)

Ammunition Usage for Operation Iraqi Freedom

1. How much ammunition was consumed by V Corps during the first 21 days of Operation Iraqi Freedom (first twenty-one days--major combat operations) (see table 18)?

Table 18. Ammunition Usage for Operation Iraqi Freedom				
Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS	9000	548	6 %	.14
120-millimeter Rounds	65,000	1,576	2 %	.26
TOW Missiles	8,500	375	4 %	.06
25-millimeter Rounds	702,000	16,026	2 %	2.44
Hellfire Missiles	25,000	462	2 %	.14
2.75-inch Rockets	155,480	1,338	Less than 1 %	.41
30-millimeter Rounds	750,000	35,057	5 %	10.91

Battle Command Training Program

During an interview conducted with a systems analyst, the researcher learned that the simulation system does not capture the number of rounds fired for an M1 Abrams tank or an M2 Bradley fighting vehicle. Therefore, the Battle Command Training Program table (table 19) for those two weapons systems will not reflect ammunition consumed. However, there was a recent Battle Command Training warfighter exercise conducted that did capture accurate data on the use of MLRS, 2.75-inch hydra rockets, 30-millimeter rounds, and Hellfire missiles (Dempsey 2004).

There are too many variables that can be interjected into the system that create artificiality that may skew the study. Most information from warfighter exercises is not focused on logistics. So that type of data is not normally gathered in a controlled manner. However, the United States Army's Battle Command Training Program sometimes conducts focused rotations in which controls are in place to gather specific data. One

warfighter exercise focused on collecting information on MLRS and AH-64 attack helicopter ammunition usage (Dempsey 2004), which provided the data for this study.

Lethality within simulation systems is not relevant in this study. The reason is because the simulation can be adjusted for lethality and survivability. The simulation is adjusted so that the opposing force weapon systems and United States weapon systems have similar lethality and survivability characteristics. The Battle Command Training Program is designed to train commanders in decision making during combat, not to capture ammunition usage. If the simulation were adjusted for realistic lethality and survivability, then the United States weapon systems would make commander decisions less evident. A bad decision would be more forgiving with superior equipment. The opposing force would not be able to compete with the United States weapon systems. Therefore, a commander could make any battle plan work.

Battle Command Training Program Ammunition Usage

1. How much 120-millimeter M1 Abrams tank ammunition was used?

Not applicable. The ammunition rate for the M1 Abrams tank in simulation is calculated by several factors that are not realistic enough to use in this study. The factors are distance from target, what types of target, and hit-kill ratio of the target versus the hit-kill ratio of the M1. The computer in simulation uses an algorithm to determine if the target is killed or not. Additionally, that same algorithm is used from the target back to the M1 to determine if the M1 is damaged or killed. Additionally, in the simulation the target and the M1 will continue to engage one another until the criteria are met for a kill. However, the one factor not included in the algorithm is the 90 percent hit-kill ratio of the M1 Abrams tank at any distance (Dempsey 2004). This is not realistic because the M1

accuracy at 3,500 to 4,000 meters is also given to the opposing force's equipment. There is a great difference in the range that the United States equipment can engage targets. The enemy tanks do not have the same capabilities that United States tanks do.

During Operation Desert Storm and Operation Iraqi Freedom the enemy tanks were easily defeated by the M1 tanks. The enemy tanks did not have the survivability and had very minimal lethality against United States equipment. The enemy tank had zero lethality against the M1 tank.

The ammunition rate for the M2/3 Bradley infantry fighting vehicle in simulation is calculated by several factors that are not realistic enough to use in this study. The factors are distance from target, what types of target, and hit-kill ratio of the target versus the hit-kill ratio of the M2. The computer in simulation uses an algorithm to determine if the target is killed or not. Additionally, that same algorithm is used from the target back to the M2 to determine if the M2 is damaged or killed (Dempsey 2004).

The next data in table 19 is from a focused rotation, where the data was saved on the AH-64 attack helicopter and MLRS. The data in table 19 was not tampered with by any means of "magic resupply." Therefore, this data was accepted as accurately portraying what would be necessary to obtain the same battlefield effects outside of simulation.

The Battle Command Training Program conducts these focused exercises at the direction of the Chief of Staff of the Army. This is done normally to answer a question in regard to strategic planning.

Table 19. Ammunition Usage for Division Warfighter Exercise				
Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS	276	125	45 %	1.74
120-millimeter Rounds	N/A	N/A	N/A	
TOW Missiles	N/A	N/A	N/A	
25-millimeter Rounds	N/A	N/A	N/A	
Hellfire Missiles	1,344	1,102	82 %	15.31
2.75-inch Rockets	6,048	2,480	41 %	34.44
30-millimeter Rounds	29,400	6,174	21 %	85.75

Additional information and factors that need to be considered are:

1. Hit-kill factors at the Battle Command Training Program are almost equal for the M1 Abrams tank and the opposing force's weapons system. This gives the opposing force an unrealistic advantage.

2. The range at which the opposing force's weapons systems can kill Army vehicles also gives an unrealistic advantage. There have been exercises where the hit-kill factors have been adjusted to more accurately portray the enemy's realistic capabilities. Those exercises are usually mission rehearsals. During training the opposing force's hit-kill factors are increased in order for the simulation to be more challenging to force good maneuver and excellent combat decisions.

3. The reality is that the M1 Abrams tank has a very distinct advantage over enemy vehicles. As stated in chapter 2, the lethality and survivability are not accurately portrayed in simulation at the Battle Command Training Program or at the National Training Center.

The multi integrated laser engagement system equipment gives the opposing force an equal survivability and kill capability as the United States military. The multi integrated laser engagement system equipment also makes the ranges equal for the opposing force and the United States Army. This is another unrealistic ability of an opposing force that faces United States forces. The hit-kill percentage of the M1 Abrams tank is 90 percent. Additionally, "on average an M1 Abrams out-ranged an Iraqi tank by more than 1000 meters" (22nd Support Command 1992). To train in mission rehearsal exercises, the training centers should use the real capabilities of the enemy's equipment. As the enemy's equipment advances, the training devices can also be upgraded to show the true capabilities.

Information from National Training Center After-Action Reviews

The National Training Center keeps extensive data on every rotation. The researcher used the live-fire data from the offense and defense. The live-fire data is even more closely monitored at the National Training Center. There is a dedicated live-fire team that accounts for every round fired at the National Training Center including 120-millimeter tank rounds, 25-millimeter Bradley rounds, and TOW missiles. Additionally, the team tracks the number of targets presented and whether the target was a T80 tank, a BMP armored vehicle, or dismounted troops (National Training Center 2004).

This researcher analyzed the average of ten National Training Center rotations. The number of targets exposed was averaged from the ten rotations. The ten rotations were composed of the last two rotations of fiscal year 2002 and eight rotations for fiscal year 2003. The definition of exposed is the number of targets that pop up to be engaged or fired upon. The number of rounds to kill each target was averaged.

The live fire is normally two offensive days and a defense day. For the purpose of this research the two days of offense was combined to determine the average rounds fired.

Lethality at the National Training Center is very similar to the lethality at the Battle Command Training Program. The multi integrated laser engagement system ranges are set the same for opposing force and the United States equipment. The setting for survivability is also set very close to equal. These factors force maneuver commanders to make better plans and decisions during combat.

Table 20 shows the ammunition used for a brigade live-fire exercise at the National Training Center. The table also illustrates the amount of ammunition on hand and the percentage of ammunition that was consumed.

Table 20. Ammunition Usage for National Training Center Brigade

Weapon System	Ammo on Hand	Ammo Consumed	% Used	Rounds per Tube, per Day
MLRS	N/A	N/A	N/A	
120-millimeter Rounds	880	582	66 %	3.31
TOW Missiles	47	47	100 %	.13
25-millimeter Rounds	10,800	4,038	37 %	11.22
Hellfire Missiles	N/A	N/A	N/A	
2.75-inch Rockets	N/A	N/A	N/A	
30-millimeter Rounds	N/A	N/A	N/A	

NOTE: Two reasons for the TOW missile number to be so low are: (1) The cost of the missile does not allow for a large amount of them to be expended in training, (2) The wire left behind, as residue must be cleaned up in order to restore the training area. Additionally, during offensive operation the vehicles can tangle up the wire and create safety hazards in the environment. So they use a reduced amount of TOW missiles on the offensive operation at the National Training Center.

In the examination of tables 21, 22, and 23, the percentage of usage is equal to or less than the amount of targets exposed and the number of weapon systems participating. Additionally, there are trends developing--one is that the military uses a much lower amount of ammunition on hand in actual combat operations than it uses in training exercises. The second is the military begins training exercises with a lot less ammunition on hand than it has at the beginning of actual combat operations. There are two reasons that the military begins training exercises with less ammunition than in combat operations. The first is that when using live ammunition in training the turn in process for unused ammunition is very difficult, so there is an analysis of how many targets will actually be engaged. Also, training is set up not to use more than one basic load of ammunition. The reason in simulation to start with less ammunition is to exercise the logistic system for the supply planners.

Table 21. Average Number of Targets Presented at the National Training Center

Target Type	Offense	Defense	Remarks
T80 Tanks	22	50	54 % less in the offense than in the defense
BMPs	50	95	47 % less in the offense than in the defense
Dismounts	150	50	300 % more in the offense than in the defense

Note: The difference in the number of dismounts is because of the order of battle in the scenario. The scenario is that the enemy is dismounted in the defense in dug in positions in order to create realistic environment. However, the number of dismounts does not affect the outcome of this study, because the weapon systems studied are not primarily used to destroy dismounted troops.

Table 22. Average Number of Rounds Fired at the National Training Center			
Ammunition	Offense	Defense	Remarks
120-millimeter Rounds	159	423	63 % less in the offense than in the defense
25-millimeter Rounds	1592	2446	45 % less in the offense than in the defense
TOW Missiles	2	45	96 % less in the offense than in the defense

Table 23. Average Number of Weapon Systems Participating at the National Training Center			
Type of System	Offense	Defense	Remarks
M1 Abrams Tank	14	44	68 % less in the offense than in the defense
M2 Bradley IFV	28	90	69 % less in the offense than in the defense

In order to create a feasible test the researcher had to look at two additional pieces of information: what percentage of a basic load was consumed in operations and exercises and how many basic loads were available at the outset of the operations or exercises?

In table 23 takes the basic combat load for each weapon system involved in each operation or exercise is multiplied it by the number of systems in order to get the total amount of ammunition for one basic load for the entire theater. That total is the amount of ammunition required to have every weapon system at the full basic combat load at the beginning of the operation or exercise. The next step is to divide that number into the total amount of ammunition on hand in theater. From that information it can be determined how many times all systems could have been fully reloaded (if it had completely expended all ammunition) with a full basic combat load. Once the calculation

is complete, the basic load is then compared with the actual amount of ammunition used during the operation or exercise.

With the new Brigade Combat Team concept of basic loads, the amount of ammunition on hand would be about three combat loads: one combat load on the weapon system, one in the forward support company, and one in the brigade support battalion.

Table 24. Basic Combat Load Amounts and Total Ammunition on Hand

	M1 Basic load / Total in theater	M2 Basic load / Total in theater	AH-64 Basic load / Total in theater	MLRS Basic load / Total in theater
Operation Desert Storm	47,120 / 206,075 120-millimeter	330,000 / 3,694,255 25-millimeter	328,800 / 586,652 30-millimeter	4536 / 17,145 Rockets/ Missiles
		11,000 / 18,564 TOW Missiles	2192 / 11,516 Hellfire Missiles	
			11,508 / 52,319 2.75 Rockets	
Operation Iraqi Freedom	8,880/ 65,000 120-millimeter	468,000 / 702,000 25-millimeter	183,600 / 750,000 30-millimeter	2,376 / 9,000 Rockets/ Missiles
		1,560 / 8,500 TOW Missiles	1,224 / 25,000 Hellfire Missiles	
			6,426 / 155,480 2.75 Rockets	
BCTP Division Exercise	N/A	N/A	21,600 / 29,400 30mm	432 / 276 Rockets/ Missiles
			144 / 1,344 Hellfire Missiles	
			756 / 6,048 2.75 Rockets	
NTC BDE Live-Fire Exercise	1,760 / 2,320 120-millimeter	135,000 / 106,200 25-millimeter	N/A	N/A
		450 / 47 TOW Missiles		

There are additional ways to look at ammunition consumption that may help more accurately predict the future. The Army could use historical data by taking the percentage

of a basic load that was used in Operation Desert Storm and what percentage of a basic load was used in Operation Iraqi Freedom. This analysis compared the data from table 24 and table 17 in order to illustrate the percentage usage of one basic load for Operation Desert Storm of the four-day period of ground combat. The researcher used table 17 to show the same comparisons for Operation Iraqi Freedom.

The most significant piece of data in this part of the research was that the MLRS was the only system that used more than one basic load. The basic load for all MLRS systems equals 4,536 rockets, and during the operation the MLRS used a total of 6,604 rockets. Another factor for the large use of MLRS during Operation Desert Storm was that it was used extensively for counterfire missions. Also, the directive to reduce collateral damage during Operation Iraqi Freedom put additional restraints on the use of MLRS. The usage on MLRS rockets in Operation Iraqi Freedom was 23 percent of a basic load over the twenty-one day period. There was never a time when any launcher was critically low on ammunition in either operation.

The M1 Abrams ammunition used in Operation Desert Storm was 30 percent of a basic load over a four-day period compared to 18 percent of a basic load over a twenty-one-day period. This comparison shows two things that can be used in future planning. The first is that the Army does not use up a basic load during either combat operation. The second is that planners can depend on this data in most any scenario--heavy armor-on-armor or light-armor resistance.

The same conclusion can be made for the M2 Bradley in both conflicts. In Operation Desert Storm the M2 used only 9 percent of a basic load of TOW missiles, but did use 50 percent of a basic load of 25-millimeter ammunition over the four-day combat

operation. Comparing this to Operation Iraqi Freedom, the M2 used 24 percent of a basic load of TOW missiles and only 4 percent of a basic load of 25-millimeter ammunition over a twenty-one-day combat operation. This information is important for planners to use in the future. The most important thing that a planner needs to take away from this research is that the Army has never used up the basic load in the entire span of the operation. So the need for large amounts of ammunition resupply is not that great.

The final comparison is with the AH-64 attack helicopter. The expectation of the attack helicopter is that it will be able to expend several basic loads in one day. The helicopter has the capability to fly back to a rearming and refueling area as needed. However, that expectation has several factors that need to be taken into consideration. One is that the helicopter will have enough targets to engage to expend all of its ammunition, and the second is that the weather will allow the helicopter to be used.

The number of Hellfire missiles used in both Operation Desert Storm and Operation Iraqi Freedom was 38 percent of one basic load with the only difference being the duration of the operation. However, the amount of 30-millimeter ammunition used in the two operations is quite different--9 percent of one basic load in Operation Desert Storm in comparison to 19 percent of one basic load in Operation Iraqi Freedom. This can possibly be attributed to the type of enemy the Army fought in the two different operations. Finally, the amount of 2.75-inch rockets was 18 percent of one basic load consumed during Operation Desert Storm and 21 percent of one basic load consumed during Operation Iraqi Freedom.

In comparing the usage of ammunition in both operations there is a great deal of information that can be used in future planning. The planners need to know that in the

past two major conflicts the Army has not come close to using one basic load worth of ammunition for the weapons systems studied in this thesis. Therefore, the transportation assets could be used more effectively elsewhere, for more critical items.

Tables 25 and 26 contain the calculations of what ammunition should have been consumed in each operation and exercise using the tables from FM101-10-1/2, *Staff Officers' Field Manual Organizational, Technical, and Logistical Data Planning Factors*. These tables are created by taking the operation or exercise and determining how many of what type of weapon system participated. Then it was determined whether the operation was offensive or defensive, and the length of the exercise was also determined. From those factors used in table 2, a column was created to show what ammunition should have been consumed. Finally, the actual amount of ammunition consumed was compared to actual versus predicted usage to identify differences.

Table 25. Operation Desert Storm Calculations from FM 101-10-1/2 and Actual Ammunition Usage

	FM 101-10-1/2	Actual Usage	Difference in Percentage
120-millimeter Rounds	93,062	14,061	15 Percent
TOW	50,600	964	2 Percent
25-millimeter Rounds	1,234,200	165,295	13 Percent
Hellfire Missiles	13,974	843	6 Percent
2.75-inch Rockets	15,618	2,035	13 Percent
30-millimeter Rounds	552,658	28,621	5 Percent
MLRS Rockets	52,353	6,604	13 Percent

Note: The calculation is for four days of combat in Operation Desert Storm.

Table 26. Operation Iraqi Freedom Calculations from FM 101-10-1/2 and Actual Ammunition Usage			
	FM 101-10-1/2	Actual Usage	Difference in Percentage
120-millimeter Rounds	77,922	1,576	2 Percent
TOW	39,000	375	1 Percent
25-millimeter Rounds	859,248	16,026	2 Percent
Hellfire Missiles	41,616	462	1 Percent
2.75-inch Rockets	39,933	1,338	3 Percent
30-millimeter Rounds	1,512,864	12,057	Less than 1 Percent
MLRS Rockets	158,004	548	Less than 1 Percent

Note: The calculation is for twenty-one days of combat in Operation Iraqi Freedom.

The Logistical Estimate Worksheet was used to create table 26. The formulas in the Log Estimate Worksheet were used to calculate the ammunition consumption rate for Operation Iraqi Freedom.

Table 27. Operation Iraqi Freedom Calculations from Logistical Estimate Worksheet and Actual Ammunition Usage			
	Logistical Estimate Worksheet	Actual Usage	Difference in Percentage
120-millimeter Rounds	9,303	1,576	17 Percent
TOW	6,426	375	6 Percent
25-millimeter Rounds	179,340	16,026	9 Percent
Hellfire Missiles	1050	462	44 Percent
2.75-inch Rockets	1,869	1,338	71 Percent
30-millimeter Rounds	19,026	12,057	63 Percent
MLRS Rockets	16,107	548	3 Percent

Note: The calculation is for the 21 days of major combat operations of Operation Iraqi Freedom.

Tables 28 and 29 illustrate the forecast from FM 101-10-1/2 and actual ammunition usage in a division warfighter exercise at the National Training Center.

Table 28. Division Warfighter Exercise Calculations from FM 101-10-1/2 and Actual Ammunition Usage			
	FM 101-10-1/2	Actual Usage	Difference in Percentage
120-millimeter Rounds	14,062	N/A	N/A
TOW	5,152	N/A	N/A
25-millimeter Rounds	125,664	N/A	N/A
Hellfire Missiles	918	1,102	102 Percent
2.75-inch Rockets	1026	2,480	17 Percent
30-millimeter Rounds	36,306	6,174	17 Percent
MLRS Rockets	4,986	125	3 Percent

Note: The calculation is for the four days of a division warfighter exercise.

Table 29. National Training Center Calculations from FM 101-10-1/2 and Actual Ammunition Usage			
	FM 101-10-1/2	Actual Usage	Difference expressed in Percentage
120-millimeter Rounds	2,068	582	28 Percent
TOW	990	47	5 Percent
25-millimeter Rounds	27,270	4,038	15 Percent
Hellfire Missiles	450	N/A	N/A
2.75-inch Rockets	594	N/A	N/A
30-millimeter Rounds	19,638	N/A	N/A
MLRS Rockets	N/A	N/A	N/A

Note: The calculation is for the two days of a National Training Center rotation.

After analyzing tables 25-29, research shows that FM 101-10-1/2 grossly overestimates the ammunition consumption. This could cause a great misuse of transportation assets during combat operations.

Table 30 is a summary of rounds per system, per day. The significance of this table is the ability to compare the planning figure from the Logistical Estimate Worksheet to the actual usage in combat and training.

Table 30. Summary of Rounds per System, per Day

Weapon System	Planning Figure	Desert Storm	Iraqi Freedom	BCTP	NTC
120-millimeter Rounds	1.19	2.98	.26		3.31
TOW	.19	.11	.06		.13
25-millimeter Rounds	20.53	18.74	2.44		11.22
Hellfire Missiles	.55	.77	.14	15.31	
2.75-inch Rockets	.87	1.86	.41	34.44	
30-millimeter Rounds	4.44	26.11	10.91	85.75	
MLRS Rockets	4.91	1.4	.14	1.74	

In summary, all calculation of ammunition usage is extremely high. The good aspect of the high calculation is that the military will not run out of ammunition. The bad aspect of being grossly overcalculated is that the transportation assets that are required to move such ammunition are more than likely needed to do something else.

There are several facts that can be identified from table 31. The first fact illustrates that using FM 101-10-1/2 to forecast ammunition results in numbers that are too high and should not be used to forecast ammunition in the future. The second observation is that the Logistical Estimate Worksheet that was developed after Operation Desert Storm and that used the data from Operation Desert Storm is more accurate at forecasting ammunition. The Logistical Estimate Worksheet is a good tool. But, it could still use some refinement. The final fact is that the ammunition usage in Operation Iraqi Freedom was still overforecast. However, part of that overestimation can be attributed to the fact that the original war plan called for more weapon systems to be in theater. The

ammunition was available to support that original plan and therefore would be seen as an overcalculation with the reduced number of weapon systems used in this study.

Table 31. Ammunition Forecasting Model Comparison-- Rounds per Weapon System, per Day

Weapon System	FM 101-10-1/2	LEW	Desert Storm	Iraqi Freedom
MLRS	75	4.91	1.4	.14
120-millimeter Rounds	16	.75	2.98	.26
TOW Missiles	5	.08	.11	.06
25-millimeter Rounds	174	20.53	18.74	2.44
Hellfire Missiles	12	.55	.77	.14
2.75-inch Rockets	21	.13	1.86	.41
30-millimeter Rounds	628	4.44	26.11	10.91

CHAPTER 5

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

> Modern weapons systems and technology, in the hands of well-trained and well-led forces, provide a decisive edge in modern combat. United States ground forces had equipment that enabled them to defeat the Iraqi forces decisively in Operation Desert Storm and Operation Iraqi Freedom. Moreover, United States forces were trained to maximize this equipment's effectiveness. Tough training, a technological edge, and continued modernization are crucial to ensuring the lethality of the smaller future force. (2004, 55)
>
> Department of Defense

Conclusions

Primary Research Question

In modern warfare, utilizing current equipment, does the United States Army correctly forecast the amount of ammunition it will use in combat operations? The answer to this question is no. In fact, the Army has realized that the FM 101-10-1/2 has no more use in forecasting ammunition. Also, FM 4-30.1, *Munitions Distribution in the Theater of Operations,* states: "A review of United States Army involvement in recent operations clearly indicates the need to improve logistical planning. It is critical that Class V support planning be detailed and threat-based" (Department of the Army 2003, 4-2).

This research from the Log Estimate Worksheet also shows the same amount of ammunition would be used defending against or attacking the same amount of enemy forces by the same amount of United States Army forces. Therefore, the Army needs only one formula for calculating ammunition for combat operations. The research suggests that the current formula in the Logistical Estimate Worksheet with some adjustments

would still be valid. A closer look at the Logistical Estimate Worksheet shows that the attack, delay, and prepared defense use the same number to forecast ammunition. Military professional development schools may want to teach that is does not require any more ammunition in the defense than it does in the offense.

Implications

The implications of this study are that the range, accuracy, and lethality of the United States weapons system appear to reduce the ammunition requirements of modern warfare.

The implications of second- and third-order effects would be that many of the transportation assets used to move the overabundance of ammunition is wasted. For example, in the book *Moving Mountains* the ammunition forecast is 9,000 tons daily. The amount of common-user, land transport assets that are needed to move that much materiel is 450 transporters daily. The issue that the researcher had with this information was that in the book it appears to be a huge success. The equation that was shown in the literature review (45-4=65) should bring to someone's attention that the Army does not do well in the calculation of the forecast of ammunition during logistical planning. Taking a closer look at the mathematical equation, it has a value of sixty-five days worth of supply which equals to an overestimate or forecast of 62 percent of the forty-five days originally planned. Additionally, historical data shows a surge of ammunition consumption in the beginning of a conflict and then tapers off to low level of consumption. This disconnect in the numbers could be one of two things. The first may be a command directive to have 60 days worth of supplies on hand. The other, and the belief of the researcher, is that the

amount of ammunition forecast per round, per weapon system, per day was high and with throughput of supply the stockpile would naturally increase.

Another potentially fatal flaw in the logistical view might be failure to identify that the military has overestimated that ammunition consumption rate. The reason it is a flaw is because it will be continued. Instead of getting a more accurate method, the Army may have an attitude of “that is the way it has always done it” or “it worked before.” Additionally, the use of fewer ships for moving ammunition stocks would free those assets to move more combat power or combat enablers. The research does not deal with how much cargo space these large quantities of ammunition actually occupy on ships or in warehouses.

Recommendations

The research discovered myriad other areas that are recommended for further study.

1. One recommendation is to conduct a study of small-caliber weapons--especially for Operation Iraqi Freedom.

2. Table 32 describes battle damage by unit and types of targets destroyed. This data was gathered through the use of the gun camera systems in the helicopters. Additionally, further research should be done to discover if the success of attack aviation in Operation Desert Storm had any significant impact on planning for Operation Iraqi Freedom. A recommendation that a battle damage assessment table (see table 33) be developed for the M1 Abrams tank and the M2 Bradley as done for AH-64 attack helicopter as seen in table 33.

Table 32. Battle Damage Assessment Chart for Aviation Units in Operation Desert Storm

UNIT	Tanks	Armored Vehicles	Artillery	Wheeled Vehicles	Bunkers/ Buildings	Other	Total
1/24th	33	50	38	54	5	8	188
1/101st	0	6	3	18	5	22	54
1/82nd	3	7	3	5	5	0	23
5/6th	0	0	5	35	0	2	42
3/227	0	0	7	3	24	6	40
2/227	25	0	0	0	0	92	117
2/6th	57	41	15	48	24	0	185
2/1st	35	54	41	23	10	0	163
4/229th	33	39	2	18	3	1	96
3/1st	77	31	6	71	30	0	215
1/1st	15	7	1	27	0	0	50
Total	278	235	121	302	106	131	1173

Source: General Accounting Office, National Security and International Affairs Division, *Apache's Performance in Desert Storm* (Washington, DC: General Accounting Office 20 April 1992), 39.

3. It would be beneficial to have these same types of tables created for Operation Iraqi Freedom. Important trends may be identified and may be gathered from the creation of these types of tables in weapons effects areas (see table 33).

Table 33. Battle Damage Assessment Chart for Aviation Units in Iraqi Freedom

UNIT	Tanks	Armored Vehicles	Artillery	Wheeled Vehicles	Bunkers/ Buildings	Other	Total
11th AHR							
101st AA							
3rd ID							

4. Another interesting study would be in the aviation field comparing details from the General Accounting Office to similar data gathered for Operation Iraqi Freedom. The researcher believes that possible lessons learned in Desert Storm may have been implemented in Operation Iraqi Freedom. The areas studied should be chain gun malfunction and Hellfire missile accuracy. The researcher believes that the 76 percent hit rate achieved in Operation Desert Storm will be higher for Operation Iraqi Freedom.

5. Using the Battle Command Training Program as a test base is not recommended for future studies, unless the area to be studied is simulation related. Additionally, the logistical data collected at the Battle Command Training Program should never be used to validate any method of forecasting ammunition requirements.

6. The researcher recommends that the Army needs a major change in the way it forecasts ammunition for operations. There are three courses of actions that could be studied. The first is a history-based forecast. The second is a target threat-based forecast and the final course of action is a combination of the two.

The first of those courses of action is that the Army needs to make up a recent history-based forecasting formula. That can be done from data from this research and possibly exploring other operations, such as Panama and Somalia. The data can be collected from any operation that has consumed ammunition over a period of one day or more. From the data gathered in this thesis, the ammunition consumption rates can be determined for four weapon systems. The Army should rewrite the calculation formula for ammunition consumption using modern data.

The second course of action should begin with a target-based enemy threat analysis in order to predict ammunition usage. The ammunition usage estimate would be more accurate if the enemy array is taken into account.

The capabilities exists that would assist in forecasting ammunition requirements as the military develops the intelligence preparation of the battlefield. During the intelligence preparation it is known how many possible heavy-armored, light-armored, artillery, and other vehicles the enemy has at its disposal. It is possible that the military could develop a total number of targets from that list. Also, during the logistical preparation of the battlefield, all these details should be incorporated into the plan to mutually support each other.

The final course of action, the preferred method recommended by the researcher, is a combination of both historical data and enemy target-based threat analysis, along with the experience of the individuals planning the operation. An additional factor that could be taken into account in developing an ammunition consumption rate could be the fact that during the last two major conflicts, in most cases, the weapon systems did not use one basic load worth of ammunition. So another possibility could be the basic load is where the table begins. The Army could plan on carrying two basic loads--one would be carried by the system and the field logistical train will carry and supply the second basic load as needed. This method would have worked in both conflicts. The only issue would have been with MLRS in Operation Desert Storm where 1.5 basic loads were consumed. Again, with the birth of the Brigade Combat Team concept there is a plan to have three basic combat loads available: the first is on the weapon system; the second is located at the forward support company; and the final is stored at the brigade support battalion.

Additionally, a further study could be conducted on the sizes and weights of each the ammunition and the cubic space by pallet. Then the research could take the findings of this study and figure out how much cargo space was wasted in order to prove the possibility of moving more combat equipment vice unneeded ammunition. In addition, the forecast would have to take into account other factors of mission, enemy, troops, terrain, time, and civilians. This method could be combined with the logistical estimate worksheet after the formulas within the worksheet have been updated or validated using history. The logistical planner, in conjunction with the operational planner, would need to use all means to justify ammunition consumption rates (experience, historical data, enemy target array).

The Field Manual, 4-30.1, *Munitions Distribution in the Theater of Operations*, states, "The automated operational logistics planner is the authorized method for determining munitions planning data at all levels. FM 101-10-1/2 is no longer an authorized tool for determining operational ammunition planning factors" (Department of the Army 2003, 4-1). Ammunition consumption rates for all operations, including stability and support operations, are determined using the operational logistics planner (Department of the Army 2003, 4-1). The Army should continue to use the Logistical Estimate Worksheet and constantly update the formulas as new data is collected.

While there have been numerous recommendations and courses of action that will contribute to better ammunition planning, systemic success must come from within the Army staff structure. Staffs at all levels are only as effective as their ability to integrate their actions and capabilities into a single, synchronized entity.

The case has been made that failure to pay attention to the past does, in fact, causes repetition of these failures in the future. Logisticians can update expenditure tables, estimate ammunition usage based on threat, gather more representative data, and rely more on the “on-the-ground” operational planners. All is folly without a staff that plans, prepares, executes, and assesses operations in a harmony that meets the commander’s desired intent.

The brigade combat team fighting units are a dominating force projection capability that demands logistical efficiency more than at any period in history. The Army is no longer threat based. The Army is, in fact, capabilities based and has proven a dynamic force projection across the full spectrum of conflict in the contemporary operational environment.

The Army will not be able to maintain the agility, speed, and firepower designed into the brigade combat team concept if it fails to find a logistics tempo that mirrors it. As the Army gains this capability and mind-set, combat service support will be noted at every echelon; and intelligence, operations, and logistics operations must plan and execute as one.

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