THE CASE FOR A MEDIUM TANK TO BE INCORPORATED INTO THE JOINT FORCE

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Joint Planning Studies

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14. ABSTRACT

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This research study will use a qualitative approach using several case studies to compare the requirements of tanks operating in the anticipated future environments of Megacities and amphibious assaults to the past effectiveness of tanks and the M1 Abrams while operating in similar environments. This study will answer if the U.S. needs a medium tank.

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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

THE CASE FOR A MEDIUM TANK TO BE INCORPORATED INTO THE JOINT FORCE, by Major Jeremy Zollin, 157 pages.

The M1A2 Abrams Main Battle Tank was developed as part of the "Big 5" weapons systems. These weapons systems were built to fight a Soviet threat with massive, numerically superior armored forces. Integrating into the AirLand battle concept, the Abrams was the first U.S. tank designed to be a heavy front line tank with the maneuverability of a medium tank and dominate on the open fields of European operations.

During the last three decades the Abrams has excelled when fighting in similar operating environments. Recently, the Army Capabilities Integration Center (ARCIC) published a new analysis predicting that Megacities dominate the battlefields of the 2030s and beyond. Additionally, in the interim, the National Military Strategy has conducted a "Shift to the Pacific." Because of the dispersed nature of the Pacific theater, amphibious warfare will likely dominate the near future.

This research study will use a qualitative approach using several case studies to compare the requirements of tanks operating in the anticipated future environments of Megacities and amphibious assaults to the past effectiveness of tanks and the M1 Abrams while operating in similar environments. This study will answer if the U.S. needs a medium tank.

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ACRONYMS

AAR	After Action Review
AAV	Amphibious Assault Vehicle.
AGS	Armored Gun System
ARG	Amphibious Readiness Group
ARVN	Army of the Republic of Vietnam's
ATGM	Anti-Tank Guided Missile
COIN	Counter Insurgency
CPT	Captain
COL	Colonel
HEAT	High Explosive Anti-Tank
IDF	Israeli Defense Force
IED	Improvised Explosive Device
LAV	Light Armored Vehicle
MAC-V	Military Assistance Command, Vietnam
MBT	Main Battle Tank
MEU	Marine Expeditionary Unit
NVA	North Vietnamese Army
OIF	Operation Iraq Freedom
RPG	Rocket Propelled Grenade
SAMS	School of Advanced Military Studies
SVA	South Vietnamese Army
VBIED	Vehicle Borne Improvised Explosive Devise
VC	Viet Cong

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CHAPTER 1

INTRODUCTION

Overview

> "It's the best main battle tank in the world---if you can get it there."
> The Armor (Tank) Battalion commander in the 1st Infantry Division wryly remarked as he stood watching his fleet of 70-ton M1 Abrams heavy tanks sitting parked unable to patrol in his area of operations because they are too heavy for the primitive road nets.
>
> —Quoted in Mike Sparks, "Heavy Tanks, Helicopter Fighter-bombers: An Army in Search for Battlefield Doctrine?"

The M1 Abrams Main Battle Tank (MBT) was developed in the mid-1970s to replace the aging M60 main battle tank. Tanks have served as the centerpiece platform for the U.S. Army and USMC and are designed to provide maneuver, protection, and firepower to a rapidly advancing force that delivers shock and awe to the enemy. As part of the U.S. Army's "Big 5" weapons platforms, the M1 Abrams was developed to fight a defensive battle in Western Europe against overwhelming numbers of Soviet and Warsaw Pact T-72s. Using AirLand Battle doctrine, the Army's first commander of the Training and Doctrine Commander, General William E. DePuy, believed the key to success against a Soviet invasion was a decisive early victory.[1] FM 100-5, dated 1976, emphasized this concept stating "The US Army must above all else, prepare to win the first battle of the next war.[2]" The "Big 5" would provide that initial victory while the Air Force, Artillery, and Special Forces prevented the Soviets from bringing their reserves forward and overwhelming the weakened defenders.[3]

The Soviets continued to use lessons learned from the German Blitzkrieg of World War II and their counter-attack into Germany by building massive numbers of

main battle tanks and armored forces. Their army in 1988 had 200 mechanized divisions with 53,000 main battle tanks, 48,000 artillery pieces, and 4,900 tactical air craft, organized into five theater commands.[4] The Soviets first hardened their homeland with numerous air defense systems and bunkers hundreds of feet deep, and then built a massive armored column capable of striking quickly through Europe to reach their objectives.[5]

During the development of AirLand Battle Doctrine, the U.S. Army had two tanks, the M60 MBT and the M551 Sheridan Light Airborne Tank. The aging M60 MBT, which was falling behind the Soviet MBTs, did not have the required protection to survive the 125mm T-72 fires and anti-tank weapons being developed.[6] With the massive Soviet threat and AirLand Battle Doctrine in mind, the XM1 Abrams was built to survive the Soviet tank fires and be able to continue engaging the Soviet Tanks. These requirements led to a U.S. tank design that is heavily armored to the front, very quiet to maneuver but with extended range, and able to engage enemy tanks accurately with hypervelocity rounds over long distances.[7] Over time, the M60 MBTs were retired from service in both the U.S. Army and the USMC. The U.S. Army continued to maintain the M551 Sheridan Light Airborne Tank until 1996, when it was scheduled to be replaced by the M8 Buford Armored Gun System (AGS). However, in 1996, both the M551 was retired from service and the M8 Buford AGS procurement was cancelled, making the M1 Abrams the only U.S. Tank.[8]

When operating in open fields and with an abundance of fuel and parts, the Abrams has dominated in maneuver warfare. The first and second Gulf Wars have demonstrated how effectively the M1 Abrams can destroy opposing mechanized and

armored forces. During the initial invasion in Operation Iraqi Freedom (OIF), 3d Infantry Division maneuvered through the desert to Baghdad, securing critical Lines of Communication (LOC) while continuing north. They isolated cities until infantry and Marine units could replace 3d Infantry Division.[9] Once the Iraqi Army surrendered, the M1 Abrams entered a new phase, urban and counter-insurgency warfare.

Prior to Operation Iraqi Freedom, U.S. Army doctrine, starting with Field Manual 17-10, *Armored force field manual, tactics and techniques,* published in 1942, stressed the that "Armored units avoid defended towns and cities."[10] This avoidance continued in Army doctrine for decades. FM 100-5, *Operations,* published in 1993, listed urban areas under obstacles which "Commanders plan to negotiate or avoid."[11] During this phase, the M1 Abrams performed adequately and adeptly in urban environments while conducting counter-insurgency (COIN) operations, with periods of high intensity fighting during the Battles of Najaf, Sadr City, and Fallujah.

However, these operations identified several inherent problems with the M1 Abrams open European battlefield design. The enemy had the ability to choose when and how they would attack, favoring Improvised Explosive Devices (IED), Rocket Propelled Grenades (RPG) and deep buried bombs. This allowed them to attack the M1 Abrams against its weaker top, rear, and underbelly. On October 29th, 2003, the author witnessed the first U.S. tank crewman killed by hostile fire in an M1A2 Abrams MBT. The insurgents buried 500 pounds of C-4 explosive in a dirt road, detonating it when the tank from Alpha Company, 3-67 Armor Battalion rolled over the bomb. This was the first use of a large deep buried bomb to destroy an M1 Abrams. On Christmas Eve 2005, a M1 Abrams from 1-64 Armor Battalion traveling along route Brewers in East Baghdad was

struck by an IED. The Explosively Formed Penetrator was close enough to travel under the heavily armored Chobham tank skirts and cut a fuel line, burning the tank to the ground. The author was the Company Executive Officer of the relieving company. While in East Baghdad, the company had half a dozen tanks damaged to the point of needing replacement due to the IEDs. The improvement of Russian made RPGs fired from the flanks began to neutralize and penetrate the massive armor package of the M1 Abrams.

Combined with the ability of the enemy to circumvent the protection of the Abrams, the size and weight of the tank itself created new difficulties. The width, length of the gun tube, and height prevented the Abrams from operating in many of the urban areas in Iraq. Narrow alleys and roads, crowded with parked vehicles, low hanging power lines, and the abundant dead space (area near the tank that the crew cannot observe) around the M1 Abrams prevented it from operating effectively off of the major roads inside cities. When operating on smaller roads, the M1 Abrams weight and ground pressure easily damaged the substructure and road networks of the local cities and towns, creating animosity towards the U.S. During several deployments, units received complaints from locals about the damage the tanks had caused. These limitations combined with its massive fuel requirement, led to the M1 Abrams being used primarily in static over watch positions along main supply routes, or from the outskirts of urban areas where it could provide observation. During the limited maneuvers through the tighter neighborhoods, the tank commander was forced to stand well out of the turret in order to observe the dead space near the tank and guide it effectively. This exposed the commander to enemy small arms fire and IEDs.

The USMC also outfits its three tank battalions with the M1 Abrams MBT. Their forward positioned stocks and floating expeditionary units often include companies of M1 Abrams when afloat. Because of the size, weight, and large logistical tail of the M1 Abrams, the USMC amphibious assault commanders have to make special considerations with regard to employing the M1 Abrams. The Landing Craft Air Cushioned (LCAC) can only carry one tank and cannot be pre-boated, while the Landing Craft Utility (LCU) can only carry two if the seas and beach are suitable for the landing and the LCU is not overly worn. During the Ssang Yong 13 exercise in the Republic of Korea, the USMC had to build a Trident Pier system in order to utilize cranes to offload eight M1 Abrams. Because of the limited number of LCACs, only two M1 Abrams could be brought ashore during the amphibious assault.[12] Due to these limitations, Marine commanders often will choose to forego the M1 Abrams in favor of additional Amphibious Assault Vehicles (AAV) or Light Armored Vehicles 25s (LAV-25),[13] greatly limiting the combat power ashore during the most critical portion of an amphibious assault.

Each year, the U.S. Army Capabilities Integration Center, conducts analysis on what warfare will consist of in the future as part of the Army Chief of Staff's Title 10 Future Study Plan. This analysis is used to guide the formation of U.S. doctrinal and procurement planning. During the 2014 Unified Quest, the Army predicted that in the future megacities, cities with more than ten million people, will dominate the operating environment. Whether because of the strategic importance of the cities location or the operational objectives lying within the cities, these megacities will likely become future operating environments.[14] Currently twenty-four megacities exist with half a dozen metro areas of 100 million already existing in the Asia-Pacific region. These massive urban

areas will account for over 60% of the world's population and 70% of GDP by 2030.[15] Unlike the relatively flat and simple cities of Iraq, these urban areas will include numerous high rises, suburban areas, tunnels, subways, and underground complexes, as well as mass transportation systems and complex terrain. As these megacities grow in importance, the Army must consider if its current combat platforms, and specifically the M1 Abrams, are suitable to conduct operations within the new operating environment.

In the interim, President Obama announced in 2009 that the U.S. military strategy would "Pivot to Asia." Traditionally, this region of the world has not been one the U.S. Army has planned for. The numerous islands and large water ways of the littoral environment have led to the USMC having primacy when conducting land operations in the Pacific (Korea being the anomaly). Because of the great distances and the lack of intermediate staging bases, the USMC has maintained most of its forces afloat in expeditionary units capable of conducting amphibious assaults and in prepositioned sites. The littoral regions are full of small islands, lush jungles, and complex terrain interspersed with expansive urban areas. Any future amphibious operations within this region will require special considerations by the USMC. Bringing the M1 Abrams ashore in contested or non-established ports requires deliberate and time consuming operations. With a probable increase in amphibious operations as the importance of the littoral regions increases, is the M1 Abrams the appropriate platform for the USMC?

With the rise in the importance of the littoral regions, they will remain the intermediate operating environment. Therefore, the USMC will continue to have a requirement for deploying tanks from ships in amphibious assaults for the foreseeable

future. The future operating environment for the Army will probably include several complex megacities with between ten and one hundred million people.

Problem Statement

The Abrams, although highly successful to date, was built for a different warfare and different doctrine and has already displayed capabilities gaps when operating in urban and amphibious environments over the past ten years. As these environments increase in importance, size, and frequency, there is a possibility that a new platform will be needed to fill that gap. This study will use several case studies to examine what capabilities these environments require, what capabilities the M1 Abrams provides, and determine if there is a significant gap. If that gap exists, this study will seek to answer how the joint force can mitigate that gap or if it requires procuring a new medium tank.

Primary Research Question

Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the global littorals and Megacities?

Secondary Research Questions

What are the characteristics of the future battlefield environments that will impact the operation and employment of tanks in relation to maneuver, firepower, and protection?

What are the maneuver, firepower, and protection capabilities required for a tank to operate effectively in these environments?

Has the main battle tank operated in similar operating environments in the past and how have they performed in regards to maneuver, firepower, and protection?

Are there significant capabilities gaps with the main battle tanks in regards to maneuver, firepower, and protection when operating in these environments?

Assumptions

The following assumptions are made in order to provide relevance. The interviewed USMC and US Army officers are experts in their fields and their observations are consistent with others officers in their fields of expertise.

Definitions

Medium Tank: For the purpose of this research, a medium tank is a tracked platform with a traversable turret, large caliber main gun, and significant weight, and size reduction from the M1 Abrams. Following the Fourth Tripartite Conference on Armor and Bridging in October 1957, the M60 main battle tank was introduced and the last heavy tank battalion was deactivated in 1960. The terms light, medium, and heavy tanks were dropped from the U.S. Army Doctrine in favor of a single main battle tank and Airborne Reconnaissance/ Airborne Assault Vehicle designations.

Amphibious Assault: An amphibious assault as defined by USMC doctrine consists of land forces attacking from ships to a shore against an enemy. This can be accomplished through seaborne or aircraft insertions to a shoreline in or out of contact.

Limitations

This study will not attempt to identify the requirements for the development of a medium tank. Although, this study will discuss the capabilities a new platform will require, it will not be able to determine the specific requirements the platform would be required to meet.

This study's applicability and conclusions are limited by the expertise and number of participants who ultimately partake in the study. Although the study will use the snowball method to increase the sample size and reduce bias, chance and other factors could potentially skew the results based on the participants.

This is a qualitative research multiple case study. Because it is qualitative in nature, generalizing trends between case studies from past performance and projecting into the future will depend partly on the interpretation of the cases by the reader. The study will attempt to determine trends and performance and speculate on how those trends will be impacted by the changing operational environment; however, the generalizability of the results across all cases is limited by the actual cases studied.

This study will include non-U.S. tanks in the research. This cases is used to build context and depth across the historical record. Because this case study researches a foreign military operating a foreign tank, there may be unknown factors outside of this study that have impacts on the applicability of that case study.

Delimitations

The conduct of this study does not include the use of tanks in Afghanistan during Operation Enduring Freedom. This operation would add more context to the contemporary use of tanks and the M1 Abrams; however, the sampling size for information is relatively small and the operating environment misaligned. The Canadian Army brought 15 Leopard tanks to Afghanistan in December of 2006 for use in the Kandahar province. These tanks operated primarily in the open areas of the province and not in any large urban environments. The USMC also brought a company of M1 Abrams

to Afghanistan from late 2010 through 2013. These tanks were also used primarily in the outskirts of the Helmand province and not in any large urban operations.

Conclusion

This study will seek to answer whether the US Army and USMC need to develop a new medium tank that is built to operate in the future operating environments of megacities and amphibious assaults in the littoral regions.

Chapter 2 will discuss the current relevant literature that has been written regarding the M1 Abrams in operations within urban and amphibious environments.

The third chapter will discuss the methodology used for this study. The study will consist of five cases, the Battle of Hue, the Israeli experiences in the Second Lebanon War and Operation Cast Lead, U.S. experiences in Operation Iraqi Freedom, recent Amphibious Assault exercises conducted by the USMC, and the future operating environment of megacities. From these cases, this research study will deduce what the characteristics of a successful tank in urban and amphibious assault operations are and how the M1 Abrams has performed under similar conditions.

Chapter 4 will analyze the case studies to determine if there is a significant capability gap with the M1 Abrams. It will analyze how the environment of the case studies differs from the future operating environments and its probable impacts on the capabilities of future combat platforms. Finally, the study will discuss if the M1 Abrams MBT is capable of operating in the future operating environment.

Chapter 5 will determine if the research methodology answered the secondary and primary research questions and draw conclusions from the analysis to determine if the capability gap exists, how should the U.S. Army and USMC fill that gap?

[1] "Airland Battle," Wikipedia, last modified October, 31, 2014, accessed September 27, 2014, http://en.wikipedia.org/wiki/AirLand_Battle.

[2] Department of the Army (HQDA), Field Manual (FM) 100-5*, Operations* (Washington, DC: Government Printing Office, July, 1976), 1-1.

[3] Douglas W. Skinner, "Airland Battle Doctrine" Center for Naval Analyses, Alexandria, VA, September 1988, 19-21.

[4] William Odom, "Soviet Military Doctrine," *Foreign Affairs* 67, no. 2 (Winter 1988/1989): 114.

[5] Ibid., 121-2.

[6] Robert Sunell, *Camp Colt to Desert Storm: The History of US Armored Forces* (Lexington, KY: University Press of Kentucky, 1999), 435.

[7] Kendall D. Gott, *Breaking the Mold: Tanks in the Cities* (Ft. Leavenworth, KS: Combat Studies Institute Press, 2006), 111.

[8] Josh Suthoff, "Strike Now: Why the Armored Gun System Must Be Purchased in This Fiscal Climate," *Armor: Mounted Maneuver Journal* 123, no. 2 (March-June 2014): 49.

[9] Gregory Fontenot, E. J. Degen, and David Tohn, *On Point: The United States Army in Operation Iraqi Freedom,* vol. 1 (Ft. Leavenworth, KS: Combat Studies Institute Press, 2004), 88, 134.

[10] Headquarters, Department of the Army (HQDA), Field Manual (FM) 17-10*, Armored Force Field Manual, Tactics and Techniques* (Washington, DC: Government Printing Office, March 1942), 17.

[11] Headquarters, Department of the Army (HQDA), Field Manual (FM) 100-5, *Operations* (Washington, DC: Government Printing Office, June 1993), 8-2.

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[13] Andrew Dietz, USMC, Comments made during classroom instruction on the USMC, Department of Logistics and Resource Operations, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 12 September 2014.

[14] Megacities Concept Team, "Unified Quest 2014: Megacities and the United States Army: Preparing for a Complex and Uncertain Future," Chief of Staff of the Army, Strategic Studies Group, Arlington, VA, June 2014, 4.

[15] Ibid.

CHAPTER 2

LITERATURE REVIEW

Overview

There are three main categories of sources related to the future of the M1 Abrams MBT and tanks in general within the United States Army. The first set of documents discusses whether there is a need for tanks in the future Army. These are generally a reaction to groups such as the Center for a New American Security report in May 2012 stating that the Army needs to shift heavy brigades to the reserves and cancel the Ground Combat Vehicle procurement.[1] Other research groups and organizations are more direct in stating that the days of the main battle tank have gone with the battleship.

The second set of documents discusses the perceptions about heavy armor and urban warfare. Following Russian attacks into Grozny, Israeli ground offenses in Lebanon, and the advent of numerous anti-tank weapons systems, many pundits continue to believe that tanks should not engage in cities. Numerous thesis and articles have been written discussing the capabilities of tank and the M1 Abrams specifically while operating in these environments.

The third set of documents discusses the need for a light tank or "mobile, protected firepower" platform for the airborne and light infantry. Following the cancellation of the M8 Buford AGS, the 82nd Airborne Division continued to request a replacement for the M551 Sheridan.[2] Additionally, the light brigades lack the capability to employ a platform able to attack fortified positions and support infantry maneuver.

Finally, the is general agreement within the literature on tanks and armored warfare, urban operations, and U.S. Army doctrinal manuals that identify mobility,

protection, and firepower as the base characteristics that tanks provide to combined arms maneuver. The fourth set of documents will detail this terminology and usage.

The Need for Tanks

Captain (CPT) Thomas Rebuck wrote an article for the Armor Journal titled "Subjective Thinking and the Relevancy of Heavy Armor in Modern Warfare." In this article, refuted arguments for removing the main battle tank within the U.S. Army formation. "Transformation Politics" was the belief that the Army had to justify its large budget by "transforming" into a smaller, lighter, more agile force capable of conducting operations across the full spectrum of warfare. The tank does not fit into this concept. He argued that this left the Army confused with inconsistent doctrine regarding future procurement and warfare and does not reflect reality.[3]

The second argument he refuted is that the U.S. will remain unchallenged by a ground threat and therefore does not require tanks. He argued that the perception of U.S. dominance in ground combat is only fleeting, and that the idea of interconnection between nations did not prevent World War I.[4] The third argument often made is that the Army needs forces that can be rapidly deployed in order to prevent or pre-empt conflict. With this requirement, the main battle tank is far too slow and heavy to deploy. He argued that these theorists ignore the possibility that pre-emption would fail and ground forces with enough protection and firepower would be required.[5]

The final argument discussed how technology and the changing nature of warfare will render the MBT obsolete or irrelevant. These theorists were out in force after the 1973 Yom Kippur war. Anti-tank weapons initially devastated the Israeli tanks; however, they quickly adapted tactics and used their tanks to destroy the anti-tank teams. Rebuck

argued that technology never performs up to the expectations placed on it, and dismissing proven combat vehicles on supposition is fruitless.[6] He referenced the same Yom Kippur war to demonstrate that once the initial shock wore off, the tank crews adapted their tactics and ultimately prevailed against the increased threat.[7]

In his article "Armor's Asymmetric Advantage: Why a Smaller Army Needs Mobile, Protected Firepower," MG Bill Hix discussed the need to maintain the current force ratio of Heavy Brigade Combat Teams (HBCT) to Infantry Brigade Combat Teams (IBCT). He argued that experiences in Iraq and Vietnam have taught us that tanks and mechanized forces provide an asymmetric advantage that cannot be met with light or medium (Stryker) brigades. The tank provides a greater level of protection and firepower that a light or Stryker brigade cannot provide. He argued that because light and medium brigades lack tanks that the Army needed to maintain HBCTs. They "provide the greatest versatility and agility across the range of military operations."[8]

Major Elliot Rogers wrote his SAMS thesis "What is the role of heavy armor in the Army of 2020?" in 2012. His thesis discussed the fundamental shift in how the Army is organized under the former Army Chief of Staff, General Martin Dempsey. Throughout the 20th century, the armored forces have been the centerpiece of U.S. Army doctrine. General Dempsey changed the focus to the nine-man infantry squad. Rogers discussed that although the leadership states that Armor will play a vital role in the future of warfare, they had not stipulated what that role is. He then evaluated the U.S. strategic context, the *Army Operating Concept*, and armor force capabilities. He concluded that the armored formations should remain the focal point of U.S. Army doctrine as the most capable force of executing Wide Area Security and Combined Arms Maneuver.[9]

Tanks in Cities

Dr. Kendall Gott wrote the book *Breaking the Mold: Tanks in the Cities* in 2006. In the book, he discussed the general perception that tanks avoid fighting in cities. He used five case studies where tanks were used in urban warfare to highlight the gradual changes to doctrine. The case studies included the Battles of Aachen, Hue, Grozny, Beirut, and Fallujah. In each case study he discussed the problems and solutions encountered by the attacking force. He clearly highlighted how the tanks played a pivotal role in the eventual success of those attacking forces. In his conclusion, he determined that although tanks have shortcomings with maneuver when operating in urban environments, these can be overcome through the use of combined arms with infantry. Without the tanks, the losses of infantry and possibly the outcome of each battle would have been changed.[10] The tanks provided the firepower to destroy strong points that artillery could not. He further argued that the Army must rely on the M1 Abrams until a new tank is developed, since a new tank built for urban warfare is not on the horizon.[11]

In 1999, Major Michael Harris wrote about tanks conducting Military Operations in Urban Terrain (MOUT) during his School of Advanced Military Studies (SAMS) thesis titled “Tanks: Fulfilling a Role in Military Operations in Urban Terrain”. His analysis utilized multiple case studies to discuss what tasks tanks were required to perform when conducting operations in urban environments. For his research study, he chose the Battles of Hue, Grozny, and Mogadishu to examine the tasks required for tanks in urban operations. He chose these three case studies because they represented different aspects of urban fights. Hue represented an extensive use of tanks against a formidable enemy. Mogadishu illustrated a limited use of tanks against a determined enemy. Finally

Grozny represented the antithesis of tanks in urban operations.[12] He then compared these tasks to the Army Training and Evaluation Program Publication 71-1-MTP, *Mission Training Plan for the Tank and Mechanized Infantry Company and Command Team*.[13] After completing his analysis he concluded that M1 Abrams was extremely capable of executing the tasks required to conduct urban operations and that current tank doctrine was adequate. Through the use of their firepower and protection, they performed standard tank tasks and enabled maneuver to the combined arms team. However, success in urban fights was increased by supporting tanks with combined arms maneuver and reliant upon the amount of training as a combined arms team that the units practiced.[14]

Major Alan Mosher discussed the use of light tanks with light infantry in urban warfare. His SAMS thesis was written prior to the decision to scrap the M8 Buford AGS and retire the M551 Sheridan. His thesis, "Light Armor MOUT Doctrine: Imperative Change or Business as Usual?" examined the use of light tanks in combined arms maneuver with light infantry. He conducted a multiple case study analysis of the Battles of Hue, Suez City, and Panama City.[15] From these battles he concluded that the U.S. Army does need light tanks to support the light infantry. The infantry lack the protection and firepower to engage hardened and fortified targets without the light tank. He further argued that the doctrine at the time did not sufficiently emphasize or specify how to conduct combined arms maneuver warfare in urban settings and needed to be combined into a single doctrine instead of individual doctrines for each branch.[16]

Captain J.P. Klug wrote an article for Armor magazine in the May/June 2000 edition discussing doctrine for tanks in urban environments. His article, titled "Facing up to the Urban Fight: Armor's role in future U.S. MOUT Doctrine," started with the

prediction that cities will continue to grow in size and importance and therefore require tanks to operate in urban settings. He then discussed a dozen different doctrines regarding the use of tanks in cities. His final conclusion is that doctrine for the Army needed to be updated and that Armor officers needed to study MOUT doctrine closely to prepare for the future operating environments.[17]

The Need for Light Tanks

Major Burdett Thompson wrote his SAMS thesis, "Where's the light Armor? Enhancing the firepower of early entry forces," in 1997, following the cancellation of the M8 Buford AGS and retirement of the M551 Sheridan light tank. He discussed the looming gap he anticipated by the cancellation of the M8 Buford AGS platform. Using a discussion on historical examples of tanks supporting light infantry and a comparison of doctrine dictating the combined arms team approach to urban and light infantry warfare, he concluded that the requirement for the light tank remained.[18] He argued that initial entry forces lack the protection and firepower required for seizing airfields. He then discussed the numerous systems or methods with which the Army could fill the capability gap in light of the constrained budgets of the mid-90's.[19] He concluded that the Army must find some method of closing the gap but recommended a light airborne tank.[20]

In his article "Strike Now," Captain Suthoff discussed the history of the Armored Gun System procurement and its cancellation. He then discussed the continued desire of the 82d Airborne Division to replace the M551 Sheridan and why the Army should resume the M8 Buford AGS procurement. He argued that the 82d Airborne Division had lacked the protection and firepower required to support airborne forces. He finished by providing a recommended break out of tanks to the Army's airborne forces.[21]

Colonel (COL) David Haight, in conjunction with COL Paul Laughlin and CPT Kyle Bergner, discussed the capability gap amongst all the IBCT formations. They used the battles in Iraq to highlight the inherent disadvantage of the IBCT formations with regard to mobile, protected, firepower. Using examples from Mogadishu, Iraq, World War II, and Operation Cast Lead, they argued that the IBCTs needed a platform that provides them firepower and protection while delivering the shock and awe of tanks.[22]

The Exception

During my research I found one article that specifically discussed adapting future tanks to meet the demands of urban warfare. Professor Richard Odorkiewicz wrote "Armor and Future Urban Warfare" for the March-April 2004 article in the Armor Journal. In the article he discussed the need for armor to adapt to urban conflict by upgrading ammunition, increasing the elevation and depression of the main gun, reducing the length of main gun tubes to provide maneuverability, and improving armor though new technologies. He highlighted the Russian example of the BMPT, a tank built exclusively for urban conflict after their failures in Grozny. He also dismissed the ability of light armor or wheeled vehicles to operate effectively in place of a tank because of maneuverability and protection issues.[23]

Mobility, Protection, and Firepower

The following literature reviews establish mobility, protection, and firepower as the base attributes for tanks. These three capabilities have been established as design requirements and tactical necessities for armored warfare. They are enshrined in development requirements, literature about armored warfare, and U.S. Army doctrine.

Most of the literature pieces previously reviewed, utilized the attributes of mobility, protection, and firepower when discussing the requirement for tanks. In his book, *Breaking the Mold*, Kendell Gott referenced each of these attributes when describing the success or failures of tanks in urban operations in his case studies. Colonel David Haight's article, "Armored Forces: Mobility, Protection, and Precision Firepower Essential for Future," used the three principles to structure his article. Major General Bill Hix stated in his article "Armor's Asymmetric Advantage: Why a Smaller Army Needs Mobile, Protected Firepower," that "in Baghdad's Sadr City, mobile, protected firepower was essential."[24] Finally, Major Elliot Rogers quoted Brigadier General Tom James, Chief of Armor in 2011, stating "Mobility, protection and firepower remain the key capabilities armor brings to the fight," in his SAMS monograph "What is the Role of Heavy Armor in the Army of 2020."[25]

Bradley Peniston wrote an article for the Armed Forces Journal titled "Armor: Key to the future fight: Mobility, protection and precision firepower are a winning combination." This article can be categorized in the need for tanks articles and refuted the push for technology in conjunction with the Air Force, Navy, and Special Forces replacing the need for tanks. He then described the aspects of mobility, protection, and firepower of tanks and how they contributed to modern conflicts success as well as provided flexibility to the commanders. He argued that light forces are not decisive on their own and cited multiple cases where tanks were rushed forward after decisions to leave tanks behind were negated by the realities on the ground.[26]

Several U.S. Army doctrinal manuals also used mobility, protection, and firepower as critical capabilities for tanks. The January 2016 version of ATP 3-90.1,

Armor and Mechanized Company Team, stated that "Main battle tanks provide a lethality, survivability, and mobility unmatched by any other ground combat platform."[27] ATP 3-20.15, *Tank Platoon*, written December of 2012, stated that a tank platoon, "Conducts operations requiring firepower, mobility, armor protection, and shock effect."[28] The June 2011 edition of ATTP 3-06.11, *Combined Arms Operations in Urban Terrain,* reinforced this concept, stating, "Mechanized Infantry/Armored units operating in platoon, company team, and battalion task force strength combine mobility, protection, and firepower to seize the initiative from the enemy and greatly aid friendly success."[29] These documents demonstrate that mobility, protection, and firepower are considered the bedrock of tank and armored warfare.

Finally, *U.S. Army: Combat Vehicle Modernization Strategy*, dated 15 September 2015, detailed the U.S. Army's approach to upgrading its fleet of combat vehicles. This document used mobility, protection, and firepower as the key capabilities for design. The document stated, "The strategy establishes the ends, ways and means to modernize Army combat vehicles in the near-, mid- and far- terms to meet the mobility, protection and lethality capability requirements of future Army formation."[30] This document discussed the Army's need for modernized combat platforms, the procurement process, and the capabilities requirements, centered on mobility, protection, and firepower for those platforms. These three capabilities required tradeoff with logistics and transportability in order to support the Army's future requirements.[31]

Summary

A review of the relevant literature regarding tanks and urban warfare produced three main categories. These categories were the requirement to maintain tanks in the

U.S. Army at all, the requirement for tanks to participate in combat in urban terrain, and the need for a tank platform in the light and airborne brigades. There was no discussion of megacities, and only one article discussing modifications to the current tanks for any urban combat. All of these articles were reactionary to discussions about the inability of tanks to meet a capability and the belief that tanks should be removed from the force or should avoid cities. Each article argued to maintain an armored force in the U.S. Army, demonstrated the ability of the tank to provide synergy in urban combat, or highlighted the capability gap left after the cancellation of the M551 Sheridan and M8 AGS.

The second category of literature determined that mobility, protection, and firepower are the bedrocks of armored warfare. These three critical attributes were used throughout discussions about tanks and armored warfare, ingrained in U.S. Army doctrine, and drove the capabilities requirements for U.S. Army procurement procedures.

This review determined there is a gap in literature and research on what the design requirements for a tank to be successful in urban combat are, how the characteristics of a megacity will alter those requirements, and if there is a capability gap at the medium tank level in the joint force. This study will seek to close that research gap.

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[1] David Barno, "Sustainable Pre-eminence: Reforming the US Military in a Time of Strategic Change," Center for a New American Security, Washington, DC, May 2012, 28-9.

[2] Suthoff, 49.

[3] Thomas Rebuck, "Subjective Thinking and the Relevancy of Heavy Armor in Modern Warfare," *Armor: Mounted Maneuver Journal* 121, no. 5 (November-December 2012): 20.

[4] Ibid., 22.

[5] Ibid.

[6] Ibid., 24.

[7] Ibid.

[8] Bill Hix, and Mark Smith. "Armor's Asymmetric Advantage: Why a Smaller Army Needs Mobile, Protected Firepower," *Armor, Mounted Maneuver Journal* 121, no. 5 (November-December 2012): 14.

[9] Elliot Rogers, "What is the Role of Heavy Armor in the Army of 2020?" (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 2012), 11.

[10] Gott, 114.

[11] Ibid., 115.

[12] Michael Harris, "Tanks: Fulfilling a Role in Military Operations in Urban Terrain (MOUT)," (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1999), 3.

[13] Ibid., 4.

[14] Ibid., 42.

[15] Alan Mosher, "Light Armor MOUT Doctrine: Imperative Change or Business as Usual?" (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1994), 12-34.

[16] Ibid., 41-42.

[17] J. P. Klug, "Facing Up to the Urban Fight: Armor's Role in Future U.S. MOUT Doctrine," *Armor Magazine* 109, no. 3 (March-April 2004): 7-11.

[18] Burdett Thompson, "Where's the Light Armor? Enhancing the Firepower of Early Entry Forces," (Monograph, School of Advanced Military Studies, U.S. Army Command and General Staff College, Ft. Leavenworth, KS, 1997), 19.

[19] Ibid., 25-39.

[20] Ibid., 40.

[21] Suthoff, 48-50.

[22] David Haight, Paul Laughlin, and Kyle Bergner, "Armored Forces: Mobility, Protection and Precision Firepower Essential for Future," *Armor, Mounted Maneuver Journal* 121, no. 5 (November-December 2012): 5-7.

[23] Richard Ogorkiewicz, "Armor and Future Urban Warfare," *Armor Magazine* 113, no. 2 (March-April 2004): 22-24.

[24] Hix, 14.

[25] Rogers, 47.

[26] Bradley Peniston, "Armor: Key to the Figure Fight: Mobility, Protection and Precision Firepower Are a Winning Combination," *Armed Forces Journal,* last modified 01 March 2013, accessed 17 May 2018, http://armedforcesjournal.com/armor-key-to-the-future-fight/.

[27] Headquarters, Department of the Army (HQDA), Army Techniques and Procedures (ATP) 3-90.1*, Armor and Mechanized Company Team* (Washington, DC: Government Printing Office, January 2016), 1-4.

[28] Headquarters, Department of the Army (HQDA), Army Techniques and Procedures (ATP) 3-20.15*, Tank Platoon* (Washington, DC: Government Printing Office, December 2012), 2-4.

[29] Headquarters, Department of the Army (HQDA), Army Tactics, Techniques, and Procedures (ATTP) 3-06.11*, Combined Arms Operations in Urban Terrain* (Washington, DC: Government Printing Office, June 2011), 8-1.

[30] U.S. Army Training and Doctrine Command, (TRADOC), *U.S. Army: Combat Vehicle Modernization Strategy* (Fort Eustis, VA: Army Capabilities Integration Center, 15 September 2015), 1.

[31] Ibid., 1-62.

CHAPTER 3

RESEARCH METHODOLOGY

Overview

In order to answer the research question, this study will utilize the qualitative analysis methodology of multiple case studies. The study will use five bounded case studies in order to clearly articulate which references apply.

The first case study will examine the Battle of Hue. This battle highlights the capabilities of a U.S. force with a heavy tank operating in an urban environment against a determined and effective enemy force. This case study will rely predominantly on historical texts and scholarly sources.

The second case study will examine the Israeli experiences in the Second Lebanon War and Operation Cast Lead. This case study represents a recent offensive by similarly equipped foreign heavy armored units into an urban environment against a determined enemy. This case study will rely predominantly on scholarly publications.

The third case study is Operation Iraqi Freedom. Although this operation encompassed ten years and half a dozen independent battles across different cities, the general characteristics of each city in Iraq are very similar and operations were conducted by similarly equipped U.S. Forces. The study will examine several battles within OIF for commonalities. The study will utilize both scholarly publications and interviews with U.S. Army and USMC Armor officers regarding their observations about the performance and limitations of the M1 Abrams during these battles.

The fourth case study for analysis is bounded by recent Amphibious Assault exercises by the USMC. These recent exercises highlighted the performance of the M1

Abrams as the primary tank of the USMC and its limitations. The study will use both USMC after action reviews and interviews with USMC amphibious warfare experts experienced with the deployment of the M1 Abrams during amphibious assaults.

The final case study will analyze the future operating environments. This case study will examine the megacities and amphibious warfare in the littorals and their likely impacts on maneuver forces, specifically tanks, operating within. This case will examine the anticipated growth of megacities, the characteristics of the cities, and how the megacities will influence armored operations. This study will evaluate the requirements that these operating environments will create for an armored vehicle.

The research portion of this study will answer the following research questions:

Primary Research Question

Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the Pacific theater and Megacities?

Secondary Research Questions

What are the characteristics of the future battlefield environments that will impact the operation and employment of tanks in relation to maneuver, firepower, and protection?

What are the maneuver, firepower, and protection capabilities required for a tank to operate effectively in these environments?

Have main battle tanks operated in similar operating environments in the past and how have they performed in regards to maneuver, firepower, and protection?

Are there significant capabilities gaps with the main battle tanks in regards to maneuver, firepower, and protection when operating in these environments?

Data Collection Methods

In order to collect the data required for the research analysis, the study will utilize two primary methods. The first method will examine scholarly publications related to each case study. From these publications, the study will draw themes and conclusions related to the use of tanks in that case study. The author will continue to examine various scholarly publications until they have read two new sources without gaining any additional relevant information.

The second method the study will utilize is to purposefully sample U.S. Army and USMC officers who are experts in their respective fields using a semi-structured interview process and based on the developed interview protocol. By utilizing the semi-structured format, the study will be able to create greater context and fully develop the ideas presented by the participants pertaining to the research questions. The study will utilize two distinct question guides (reference Appendix B and C). Each question guide will target a specific set of experienced U.S. Army and USMC officers. Each respondent will also be asked if they know other possible respondents who may want to be or should be requested for their input. This "snowball" effect will help to overcome any sampling bias created by the purposeful sampling process.

The first question guide will be targeted towards U.S. Army and USMC armor officers who have experience while operating the M1 Abrams in Iraq in urban environments. The interviewer will solicit their observations of its performance based on the list of research questions provided in the introduction and with the aim of developing

common themes and trends regarding the ability of the M1 Abrams to perform in urban operating environments. The interviewer will consider the data set complete after conducting a minimum of eight interviews and after three interviews do not provide any additional relevant themes or topics.

The second question guide will utilize a similar format and be focused on answering questions related to the fourth case study. The questions will be focused specifically on the employment of the M1 Abrams MBT in amphibious assaults and the resourcing, transportation, and capabilities required to place the Abrams into combat from a ship to the shore. This questionnaire will be targeted towards USMC officers with experience in deploying and employing the M1 Abrams in amphibious assault operations. The author will solicit their expertise and observations on the suitability of the M1 Abrams as the Marine Corps primary tank for amphibious assault operations. The author will consider the data set complete after conducting a minimum of five interviews and after two interviews which do not provide any additional relevant themes or topics.

Ethical Considerations

Because the study will be conducting purposeful sampling of officers there is a potential risk to participants. Statements that opinionate on the current state of the armor force and the various platforms could be perceived negatively by higher ranking officers. In order to reduce the risk to participants, the study will take the following steps.

The interviewer will provide each participant with a consent form stating the nature of the research study and the risk involved with participation. (See Appendix A). Prior to the beginning of the interview, the participants will return the consent form. The interview will be conducted with them either in person or by telephone. Interviews will

be recorded by digital audio tape. The interview protocol will inform participants not to discuss classified information or to discuss potential violations of the Uniformed Code of Military Justice. The protocol will also reinforce to the participant the voluntary nature of their participation and their ability to terminate the interview or to not answer a question. Following the conclusion of the interview, the author will transcribe the interview, have the participant review the transcript for accuracy, and erase the audio tape. In accordance with DOD Instruction 3612.02, the consent forms will be maintained for three years. These forms will be maintained at the Quality Assurance Office of the Command and General Staff College at Fort Leavenworth. The transcribed interviews will be secured in a locked container by the researcher. Participant's personal identifiable information will not be transferred to the transcripts when recording the responses of the participants. Demographic data from the participants used in the data analysis will be generalized to ensure specific participants cannot be identified through circumstance and will not be recorded on the questionnaires.

Data Analysis

In order to analyze the data for relevance to the primary research question, "Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the global littorals and Megacities?" The study will utilize a three-step analysis. This analysis will be conducted along three general areas based on the primary purposes' of a tank: mobility, firepower, and protection. These three principles were demonstrated to be the bedrock of tank and armored warfare during the course of the literature review. The relevant doctrinal references for tank platoons, armored companies, and combined arms maneuver in urban terrain all referenced mobility,

firepower, and protection when describing tactical doctrine. Furthermore, the U.S. Army procurement requirements generated by the Army Capabilities Integration Center also determined these three capabilities as the basis of U.S. Army weapons modernization process. This research study will therefor utilize these three bedrock principals of armored warfare as the base for examining the case studies.

The first level of analysis will examine each case study independently. Each study will extrapolate common themes related to the performance of tanks in urban environments. The study will determine commonalities regarding the strengths and weaknesses of the tanks involved in the case study, any improvisations the soldiers involved made to offset deficiencies in the tanks, and any performance anomalies specific to the tank being used in that case study. The study will examine the tanks in these case studies in how they performed across mobility, firepower, and protection.

The second level of analysis will examine the case studies as a set of related cases. From the themes in each case, the study will identify commonalities across the case studies related to the performance of tanks in urban and amphibious environments. This analysis will seek to answer how tanks perform while operating in these environments, what strengths and weaknesses tanks have in these environments, and what requirements these cases generate. These requirements will be examined in relation to mobility, firepower, and protection. Within these cases, the study will also examine how the M1 Abrams performed with regard to mobility, firepower, and protection and compare this to the historical requirements.

The final level of analysis will examine the fifth case study, the future operating environments, and its impacts on the requirements for tanks in urban and amphibious

operations. As cities grow larger and more complex, there is an increasing possibility of these changes will alter the requirements for tanks to operate effectively. The study will compare the operating environments in the historical case studies to the anticipated future operating environments case and determine if any characteristics in the future environments that will modify, exacerbate, or mitigate the requirements for tanks. Shortcomings of the M1 Abrams may be magnified and strengths nullified by the characteristics of the megacity. The study will then determine based on its strengths and weakness, if the M1 Abrams meets the requirements to operate in the future environment, or if a new tank design is required.

CHAPTER 4

DATA ANALYSIS

Chapter four will examine each of the five cases chosen for this research study. The five cases will be examined to determine the requirements for a tank to operate in relation to mobility, protection, and firepower in both the historical and future operating environments. The strengths and weaknesses of the M1 Abrams will then be compared to the requirements in both the historical and future environments to determine if it is capable of meeting the requirements. From this analysis, this study will answer the primary and secondary research questions. The five cases chosen for this study are the Battle of Hue, the Israeli experiences in the Second Lebanon War and Operation Cast Lead, the U.S. experiences in Iraq, the USMC experiences with amphibious assaults, and the future operating environments.

Battle of Hue

The first case study is the Battle of Hue. This case study uses the principals of mobility, protection, and firepower to examine how the United States Marine Corps utilized the M48A3 Patton main battle tank into their attack to clear the city of Hue following its overrun by communist forces from North Vietnam.

The case study will utilize primary and secondary scholarly sources review the battle, the forces and equipment involved, and the way the M48A3 responded with regards to mobility, firepower, and protection in the battle. This battle represents a use of tanks in high intensity urban combat against a determined regular force by U.S. forces in war prior to introduction of the M1 Abrams main battle tank.

Overview

The Battle of Hue began on 31 January 1968 with attacks by the North Vietnamese forces on the South Vietnamese and U.S. forces garrisoned in the city of Hue. The battle lasted until the combined South Vietnamese and U.S. forces finally cleared the city on 25 February 1968. The battle represented a turning point in the Vietnam War and is one of the only protracted and fiercely contested urban combats to occur during the war. The communist forces of North Vietnam, consisting of regular regiments of the North Vietnamese Army (NVA) and guerilla forces of the Viet Cong (VC), hoped that broad based attacks on cities would demonstrate that the South Vietnamese citizens were not safe anywhere, to include the cities that had remained largely in South Vietnamese control.[1] Hue itself was a symbol of legitimacy of the South Vietnamese government and therefore was a key target of the Communist forces in their offensive. This led to the commitment of a larger number of regular troops than to any other battle in what would become known as the Tet Offensive.

Hue's location in the northern sector of South Vietnam made it a critical location for I Corps. During the Vietnam War, Hue was located in the I Corps sector, fifty kilometers south of the former demilitarized zone, and a few miles inland from the South China Sea. The city is a fortified city with a walled fortress on the northern banks of the Perfume River and was the former capital of the Nguyen dynasty between 1802 and 1945.[2] The city served as a naval resupply point and critical logistical route for operations in the I Corps sector. Because of its importance to both the Communist forces and the U.S. Military, both sides heavily committed forces to controlling the city.

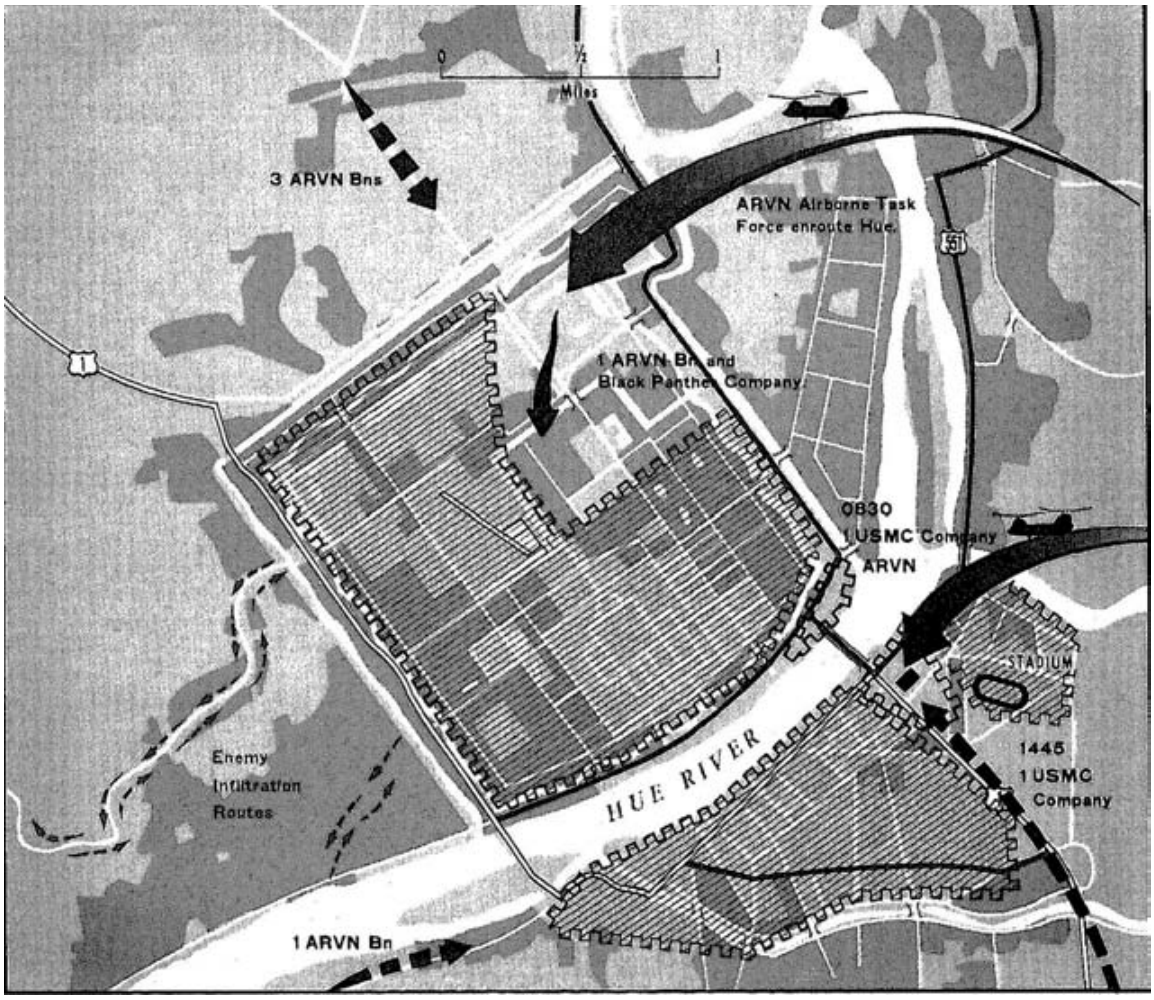

Figure 1. Combined Attack on Hue by SVA and USMC

Source: Alec Wahlman, *Storming the City: U.S. Military Performance in Urban Warfare from World War II to Vietnam* (Denton, TX: University of North Texas Press, 2015), 192.

The battle began when elements of the NVA's 4th and 6th regiment and six VC battalions attacked to seize key locations and to destroy the South Vietnamese Army (SVA) and U.S. forces within. The key objectives of the communists were the Tay Loc airfield, South Vietnamese Army of the Republic of Vietnam's (ARVN) 1st Division headquarters, and the U.S. Military Assistance Command, Vietnam (MACV) compound on the south side of the river.[3] At the start of the battle, only the ARVN 1st Division

headquarters personnel and a few dozen MACV advisors were in the city. The Communist forces captured the citadel and most of the city of Hue by the end of the day but failed to capture the ARVN or MACP compounds, preventing the Communists forces from consolidating and reorganizing forces.

After the attack began, the ARVN and U.S. forces began sending reinforcements. The U.S. forces had seven of nine Marine infantry battalions in I Corps sector, with three battalions located nearby at the Phu Bai air base. USMC helicopters airlifted ARVN airborne forces into the ARVN compound, securing it, and U.S. Marines into south Hue. 1st Battalion, 1st Marines utilized trucks to move three companies from south of Hue to secure the MACV compound on the south-east corner of the city.[4] A platoon of M48 Patton tanks traveling to Hue from 3d Marine Battalion joined the column from 1st Marine Battalion, providing critical tank support. The ARVN forces counter-attacked with several regiments and the 7th Cavalry regiment equipped with M24 Chaffee tanks to secure the ARVN compound on the north-east corner of the city. The plan was for U.S. forces to clear south Hue while ARVN forces cleared north Hue.[5] After initial operations failed, it became evident that the enemy threat was greater than anticipated and willing to fight for the city. It would take three and a half weeks using three USMC and eleven ARVN battalions to eventually clear the city.

Equipment

The Communist forces were equipped as light infantry forces, augmented with a few captured M41 light tanks, as well as sapper, mortar, and anti-tank weapons. Estimates for the number of troops vary from 7,500-10,000 soldiers. They were equipped with AK-47s, US M-1 carbines, M-16 rifles, and assorted Chinese light machine guns.

The soldiers also carried RPG variants to include RPG-2, RPG-7, B-40, B-41, and B-50s. Additionally, they had recoilless rifles and Soviet 12.7 mm machine guns.[6] Overall, the Communist forces were well armed for conducting defensive urban operations.

The USMC forces were equipped as standard light infantry battalions but were supported by a host of enabling forces. Along with the standard weapons of the M16, M1 Carbine, M79 Grenade launcher, and 60 mm mortars, the infantry battalions were supported by bazookas, M48A3 Patton main battle tanks, heavy artillery, helicopter gunships, M50 Ontos 106 mm recoilless rifles, 8 inch howitzers, air strikes, and naval gun fire.[7] The USMC forces had a strong over-match in weapons and supporting arms, which offset their disadvantage in numbers.

The M48A3 Patton was the main battle tank of the U.S. forces during the Vietnam war. It was designed to fight Soviet era tanks in the 1950's. As such, it fielded a 90mm rifled main gun, weighed in at 45 metric tons, and had an advanced fire control system, and stereoscope range finder for long range engagements. The M48A3 lacked adequate night vision capabilities.[8] The M48A3 was 11'9" ft.in wide, 10'10" ft.in tall, and 20'10" ft.in in length with barrel extending 9'7" ft.in past the front slope. The main gun could be raised 19 degrees or depressed 9 degrees.[9] Similar to the M1 Abrams, the M48A3 was designed for tank combat in open terrain and not for urban warfare.

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Figure 2. Ariel Photo of the Imperial City Hue, shortly after the fighting had finished.

Source: Peter Alan Loyd, "One of the Vietnam's War's Bloodiest Battles: Photos of Hue, Then and Now," Peteralanlloyd, accessed 23 May 2018, http://peteralanlloyd.com/ one-of- the-Vietnams-wars-bloodiest-battles-photos-of-hue-then-and-now/.

Terrain

The terrain of Hue greatly influenced the conduct of the battle. Hue is divided between north and south by the Perfume River. The northern portion of the city is dominated by the Citadel, a 2500 x 2500 meter 1820 French fortress modeled after Beijing's Forbidden City, complete with moat. Most of the northern city sits within the fortress walls. In the center is the Imperial Palace. The buildings are tightly packed with dense old-growth vegetation between and narrow streets. These features prevented any

maneuver against enemy positions and left attackers with one option, frontal attack.[10] The southern portion of Hue is more open with wide streets and greater spacing between buildings. There are several bridges but none large enough to support the weight of the M48A3 Patton.[11] These features affected how the USMC and ARVN forces fought against the Communist forces differently on the north and south sides of the river.

Mobility

The first aspect of analysis for the M48A3 Patton tank in the battle of Hue is how its mobility shaped the battle. The ability of the M48A3 to traverse the battlefield differed significantly between northern and southern Hue. Early in the battle on the southern half of the city, the mobility of the tank proved invaluable to the marines. On the first day, the 1st Marine Battalion commander used the M48A3s to plough through buildings, creating a protected pathway to the helicopter landing zone.[12] The tank's ability to drive through structures and maintain mobility aided the marines' ability to traverse the battlefield. When the streets became littered with rubble from damaged buildings, the ability to traverse the terrain enabled the M48A3 to continue to attack.[13] These aspects of the M48A3s mobility enabled the tank to support operations.

However, there were several negative aspects of the tank's mobility that would come to light. When the marines initially crossed the river to attack into northern Hue, the main bridge did not support the weight of the 45 ton M48A3.[14] The inability of the tanks to cross the river severely hampered operations. The tanks continued to follow the marines from the southern bank and provided limited covering fire but were unable to provide protection and direct firepower where they needed it most.[15] The first attacks ultimately failed and the marines were pushed back across the river. Eventually the

marines utilize landing craft to transport the M48A3s to the northern bank of the river.[16] Once on the northern bank, mobility again became an issue for the M48A3. Many of the streets on the northern Hue were too narrow for the M48A3s to traverse their main guns to engage targets or too narrow for the tanks to drive down at all.[17] The inability of the M48A3s to maneuver in areas of the northern city forced the marines to rely on the smaller and less protected M50 Ontos for support. This lack of mobility made progress on the northern side of the city proceed much more slowly and often without the tanks.

The battle of Hue demonstrated both positive and negative aspects of the M48A3 Patton tank's mobility. The tank was able to traverse difficult terrain and breach obstacles or create bypasses that supported the marines' maneuver; however, the weight and size of the tank made mobility difficult or impossible on the northern side of the city. The weight and size of a tank is directly related to the survivability of the tank.

Protection

The second aspect of analysis for the M48A3 Patton tank in the battle of Hue is how it performed in regards to protection. One of the fundamental aspects a tank brings to an battle is its ability to survive direct fire and engage enemy strong points. In the battle of Hue, the M48A3 demonstrated positive and negative aspects of protection.

There are two parts to protection, the protection of the crew, and the ability of the vehicle to take damage and continue to fight. The M48A3 proved survivable; however, the crews did not fare as well. The M48A3 armor was thicker than the previous M26 and able to withstand small arms and machine gun fire; however, it was extremely vulnerable to the modern RPGs.[18] Crews were often killed or injured. Eleven of the original fifty-five crewmen who entered the citadel with the tanks were still fighting at the end of the

battle and at times tanks were without any crew to man them. In spite of the crew losses, the tanks themselves fared well with four to five of the seven tanks operational at all times. Tanks that were damaged were generally repaired overnight.[19] The ability of the M48A3 to survive contact is what made them valuable to the marines.

To offset the vulnerability of the tank to RPGs, the marines integrated them into their maneuver. On the 13 February during the initial attack on the citadel, two M48A3s led the attack. The numerous enemy spider holes and ambush points quickly forced a retreat. The Marines then adjusted, using riflemen to clear kill zones and spider holes. When the marines became pinned down, the tanks would engage point targets and strong points with their main gun.[20] On several occasions, the marines would use the tank for cover as they advanced to new positions, providing them with protection from small arms and machine gun fire. In spite of the high casualty rate among the crew, the tanks were still able to absorb a significant amount of fire and continue to fight. One marine stated that after receiving a score of B-40 rockets, "Onlookers were sure the crew had been killed . . . Instead, the tank continued to maneuver and provide the support necessary to save the pinned marines."[21] The integration of marines and tank maneuver reduced the tanks from receiving effective anti-tank fires. The armor protection of the tank allowed it to maneuver into position to provide critical fire support to the marines and also provided immediate cover to the marines from machine gun and small arms fire.

The protection aspects of the M48A3 were both positive and negative in the battle of Hue. The tanks themselves were survivable and capable of sustaining numerous hits from enemy weapons while returning fire, providing protection to the marines on the ground nearby. The protection to the crew was less effective and often resulted in losses.

Firepower

The final aspect tanks brought to the battle of Hue was firepower. The protection of the tank enabled the crew to maneuver it to a position where it could bring direct fires to bare on enemy strong points. As stated in the Marine Corps Warfighting Publication, *Military Operations on Urbanized Terrain*, "Tanks in support of infantry act as an assault gun that delivers concentrated, sustained fires to reduce [enemy] held strongpoints."[22] The M48A3 demonstrated both positive and negative aspects of firepower in the battle.

The positive aspects of the firepower included its ability to destroy enemy strongpoints, provide suppressive fires, or create holes in buildings. While maneuvering down streets, the marines would be engaged by enemy machine gun positions and strong points. The M48A3s would pull forward to suppress these positions. Marines in the battle stated "[when] the enemy had taken up defensive positions, dismounts could not provide enough suppressive fire- however the tanks could."[23] The tanks also allowed the marines to cover multiple avenues of approach from protected positions. When trying to prevent the enemy from repositioning, the marines placed a M48 in an intersection. The tank could cover two avenues of approach by placing the main gun on one street and the cupola mounted 12.7 mm machine gun on another.[24] The tank's natural protection enabled it to provide heavy machine gun and main gun fires from positions the infantry could not. When the marines were pinned and unable to advance, the M48A3 was able to destroy walls with minimal ricochets by utilizing High Explosive Anti-Tank (HEAT) rounds. This allowed the tanks to create openings in walls for the infantry to attack through, or destroyed enemy positions with minimal shrapnel on friendly forces.[25] The biggest advantage in firepower that the M48A3 provided to the USMC in the battle of

Hue was availability. Due to weather and limitations on artillery, the M48A3 Patton and the M50 Ontos provided the marines with heavy weapons that could always be used.[26] Naval gun fire and aircraft could not be counted on when needed most and required time to call.

Although the M48A3 provided many firepower benefits to the marines, the M48A3 did suffer from some weaknesses. The 19 degree elevation of the main gun limited the ability of the tank to engage targets in upper story buildings. When maneuvering through northern Hue, the enemy would utilize upper floors to attack. A tank can only engage targets that it can bring within its sites. When the enemy was too high up, the tank was forced to back up far enough to engage, or another method of engagement was required. The second major limitation of the M48A3 is the lack of sufficient night sights.[27] The inability to identify targets at night, limited the support of firepower to the marines during the battle. Although the tank had these limitations, a captured document from the communist forces after the battle stated, “We suffered heavy casualties caused by enemy firepower and armored vehicles.”[28]

Summary

The M48A3 Patton main battle tank demonstrated strengths and weakness in the battle of hue while supporting the USMC clearance of the city. The tank mobility greatly aided operations in the southern portion of the city, pushing through buildings and climbing over rubble; however, the weight delayed deployment to the northern sector and the size limited its ability to traverse many portions north of the river. The tank’s protection is survivability of the vehicle and the protection it provided to the marines on the ground were invaluable as it allowed the marines to systematically advance behind

the tank or allowed the tank to position where it could destroy enemy strongpoints. However, the survivability of the crews was problematic and resulted in heavy losses. The greatest capability the tank provided was in its ability to place direct and heavy weapons fire on the enemy, reducing strong points, and providing suppressive fire for the marines to advance. The marines worked around the firepower limitations of the tank to employ it effectively throughout the battle.

Israel's Involvement in the Second Lebanon War and Operation Cast Lead

The second case study for examination is the involvement of Israel in 2006 in the Second Lebanon war and in 2008-9 in Operation Cast Lead. This case study uses the principles of mobility, protection, and firepower to examine how the Israeli Defense Force (IDF) utilized the Merkava A4 main battle tank in both campaigns and the lessons learned from 2006-2009 in urban and armored warfare.

The case study will utilize primary and secondary scholarly sources to review the battle, the forces and equipment involved, and the way the Merkava responded with regards to mobility, firepower, and protection in both operations. The Israeli failures in Lebanon in 2006 followed by lessons implemented prior to their operation into Gaza City provide key insights into modern urban and armored warfare and tank design.

Overview

Israel has lived in a precarious security situation since its inception. Having survived a series of major wars with its neighbors, Israel spent much of the previous decades fighting with terrorist organizations and local insurgencies. Two of the principal adversaries Israel has faced are Hezbollah and Hamas. Hezbollah is a Shiite Islamic

group founded in defiance of Israel's invasion of Lebanon in 1982 with the stated goal of making Lebanon a Shiite state. Hamas was founded in 1987 after radical Islamic Palestinians felt that Fatah, the predominant Palestinian political group at the time, was not hardline enough with Israel and seeks the destruction of Israel and the creation of an Islamic Palestinian state.[29] Both groups have continued to conduct attacks on Israel.

Prior to 2006, the last major military operation Israel fought was the First Lebanon war from 1982-2000, when asked to support Christians in southern Lebanon during the Lebanese civil war. Over the course of 18 years, Israel slowly backed out of a protracted low intensity conflict. Emboldened by Israel's withdrawal from northern Lebanon in 1985, Hezbollah continued their campaign against the occupying Israeli forces until Israel finally admitted defeat and left on 24 May 2000.[30] Hezbollah then conducted attacks into Israel using rockets and hit and run tactics on small outposts while attempting to capture IDF soldiers.[31] These attacks continued to harass Israel; however, the short range of the rockets and the lack of guidance made them generally harmless.

On 12 July 2006, Hezbollah ambushed and killed three IDF soldiers and captured two more, causing Israel to stumble into a 33 day war in southern Lebanon. Hezbollah believed they could use the kidnapped soldiers in a trade for captured operatives, believing Israel would never be willing to fight another war in Lebanon.[32] Israel responded with massive air strikes, with the intent of forcing Hezbollah to retreat from southern Lebanon and stopping future attacks into Israel.[33] Believing overwhelming airpower would devastate Hezbollah, Israel planned to continue the bombing until Hezbollah returned the soldiers, or the Lebanese government forced them to. Instead, Hezbollah retaliated by firing more accurate and longer ranged rockets into Israel.[34]

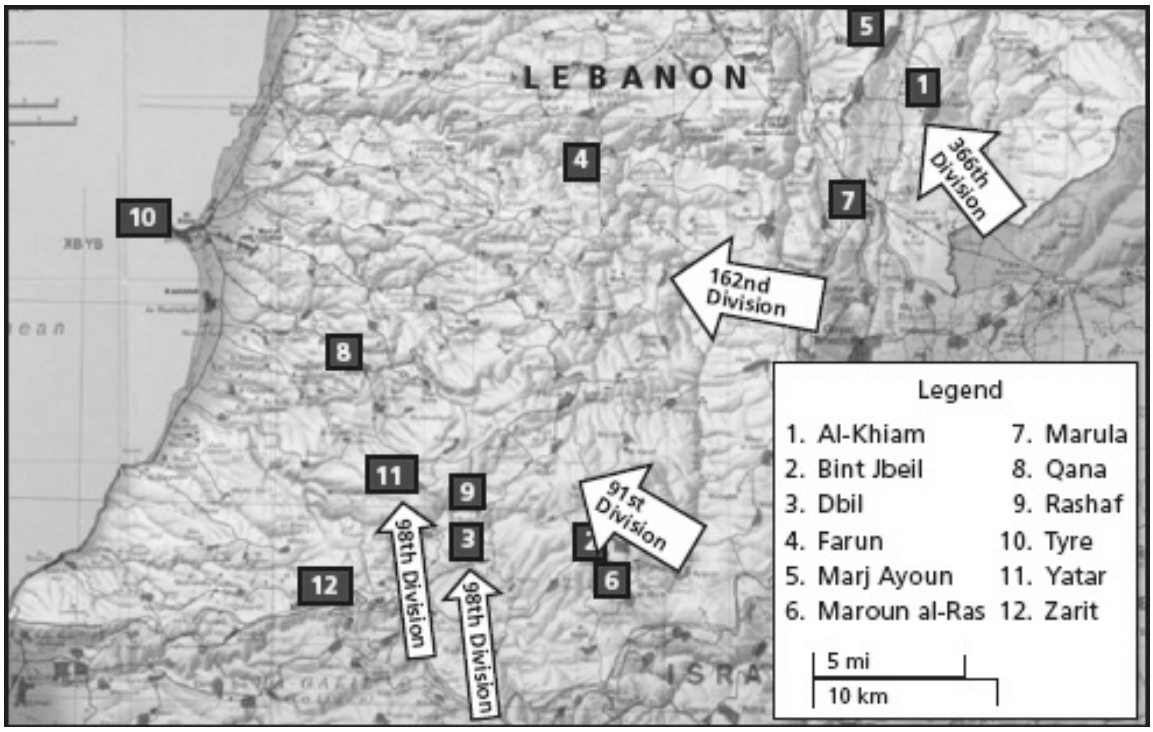

Figure 3. Map of Israeli Attack into Lebanon

Source: David E. Johnson, *Hard Fighting: Israel in Lebanon and Gaza* (Santa Monica, CA: RAND Corporation, 2011), 70.

After several days of continued bombardment, Israel committed the first of its divisions into Lebanon in an attempt to eliminate the rocket sites from the villages. On 17 July, the Maglan unit attacked Maroun al-Ras and was quickly stopped and surrounded.[35] One Israeli soldier noted that, "We expected a tent and three Kalashnikovs—that was the intelligence we were given. Instead, we found a hydraulic steel door leading to a well-equipped network of tunnels."[36] Israel suddenly realized how well prepared Hezbollah was and began to piecemeal forces into Lebanon, calling up reserves, and sending more forces to stop the tide of rockets from landing in Israel.

By 11 August, public sentiment had turned on Israel and the UN Security Council unanimously approved Resolution 1701 to implement a ceasefire.[37] Israel rushed four divisions into southern Lebanon to change the balance of negotiations and destroy as much of Hezbollah's infrastructure and capability prior to the official ceasefire taking effect. All four divisions failed to make their missions and met stiff resistance.[38] On 14 August, the ceasefire became official, ending the Second Lebanon War. Israel had been militarily defeated, inflicting minimal damage on Hezbollah and damaging Israel's greatest deterrent, the belief in a strong Israeli military.

Following the war, Israel made hundreds of commissions to determine what had led to their failures in Lebanon. The commissions conducted thorough analysis and recommended numerous changes in manning, equipping, training, and doctrine. By 2008, the Israeli military had made substantial overhauls to their military.

Starting in early 2008, Hamas began conducting rocket attacks and small-scale skirmishes with the Israeli security forces in Gaza. The IDF responded with targeted and punitive strikes and the cycle continued to unfold. By 19 June 2008, both sides welcomed a temporary ceasefire in order to recover and prepare for further hostilities.[39] Hamas had been preparing, trying to replicate Hezbollah's success in 2006; however, Israel and the IDF had learned their lessons from Lebanon and adjusted. Israel spent the next several months training and preparing its forces while gathering intelligence on Hamas targets. By the time hostilities resumed, the IDF and Israeli intelligence had completely penetrated the Hamas networks.[40] In November 2008, following a raid by the IDF, Hamas declared its intent to resume hostilities on 18 December. They resumed firing

rockets into Israel on 04 November. On 27 December 2008, Israel launched operation Cast Lead, to destroy the Hamas supplies and infrastructure in Gaza.[41]

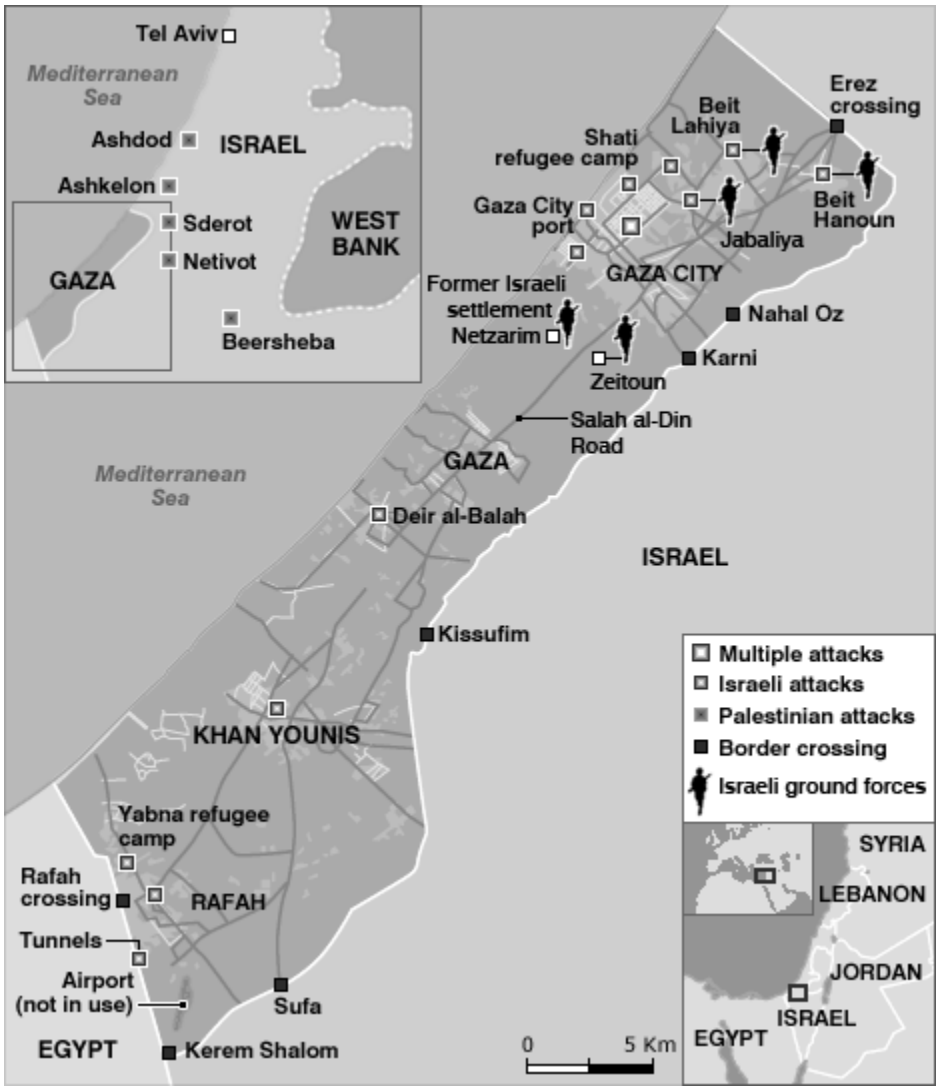

Figure 4. Operation Cast Lead

Source: BBC News, "Map: Gaza offensive - Week Two," last modified 6 January 2009, accessed 28 September 2014, http://news.bbc.co.uk/2/hi/middle_east/7811189.stm/.

Learning from Lebanon, Israel planned a ground offensive in conjunction with their air campaign. Israel conducted several days of bombings and deception operations prior to starting the ground war in order to keep Hamas from repositioning. On 03 January 2009, Israel launched its ground forces with four brigades attacking and isolating Gaza City. The brigades destroyed rocket sites and caches and captured or killed hundreds of Hamas operatives while avoiding prepared kill zones and ambushes. By 13 January, the IDF had met its objectives and continued to find and destroy Hamas infrastructure. On 18 January, the Israeli government unilaterally declared a ceasefire and withdrew from Gaza.[42] Hamas had been humiliated and much of their supplies and infrastructure outside Gaza City had been destroyed. Israel chose not to escalate with a operation into Gaza City, to protect the positive image they had rebuilt with the swift and early successes, and with the realization that continued conflict would likely increase civilian casualties and sour public opinion.

Equipment

Hezbollah's military consist of a core of elite fighters believed to be between 1,000-3,000 well trained and experienced soldiers and a reserve of village defenders estimated to be up to 10,000 fighters. The elite fighters make up teams of rocket, Improved Explosive Device teams, anti-tank teams, and anti-air teams, consisting of 3-8 personnel each. These teams form the core of Hezbollah's defense, firing rockets and protecting key locations. The village defenders form teams near their villages that conduct ambushes and protect the core fighters and rocket sites.[43] This spider web of teams serves to cause delays and confusion amongst an attacking force, allowing the core teams to continue to strike Israel with rockets and force a political settlement.

Hezbollah is well equipped and heavily supplied by Iran and Syria. Their weapons include Zelzal-2, Nazeat, Fajr-3 and 5, and 107-302 mm rockets, ATGMs to include the AT-14, AT-5, METIS-M, Tow missiles, RPGs 7 and 29, surface-to-air missiles, and advanced Iranian anti-shipping missiles.[44] They have numerous mortars and Iranian Unmanned Aerial Vehicles (UAVs). The core Hezbollah fighters train in Syria and Iran and consist of many veterans of the First Lebanon War.

Hamas's military is designed around the Qassam Brigades, their primary military force of 6,000-10,000 fighters, and augmented with part time fighters that bring their total numbers to roughly 20,000.[45] Hamas main forces are less skilled than Hezbollah's, with only a few hundred dedicated and trained skilled fighters who trained with Syria, Iran, or with Hezbollah. Hamas divides Gaza into four sectors.

Hamas stockpiled supplies and sought to acquire advanced rockets and ATGMs; however, it was less successful than Hezbollah. Hamas arms include U.S. and Israeli made small arms, grenades, ATGMs, RPGs, IEDs, mortars and rockets. Many of Hamas rockets are homemade and they have some 122mm Katyusha rockets. It is believed that Hamas acquired SA-7 and HN-5 air defense capabilities as well as RPG-29s from Iran.[46]

The Israeli Defense Forces are equipped similarly to most other standing armies around the world. The soldiers have a mix of rifles, carbines, and machine guns; carry grenades and handheld anti-tank systems; and are equipped with the Merkava main battle tank, M113 and other assorted armored personnel carriers, 155mm artillery, missiles, etc. They are supported by the Air Force which includes their attack and utility helicopters as well as a fleet of aircraft to include F-15s and F-16s, as well as transport aircraft.[47]

The Merkava main battle tanks entered service in 1978 and have since been upgraded to include the Mark I-IV variants. At the time of the Second Lebanon war, the majority were Mark II and IIIs with a few Mark IVs in service. The Merkava is 65 metric tons at 24'4" ft.in long with the barrel extending another 3'11" ft.in forward, 12'2" ft.in wide and 9' feet tall. It has a crew compartment of four and can transport six soldiers in the rear compartment. It utilizes a 120mm main gun, 60mm mortar, 12.7mm machine gun, and two 7.62 mm machine guns. Its design considerations included repair, survivability, and off-road mobility. It is one of the few tanks whose engine is in the front to provide more survivability to the crew and is capable of speeds up to 40 MPH.[48]

Terrain

The terrain of southern Lebanon greatly favors the defender. Small hills separated by deep valleys, changing terrain, vegetation, and climate in small areas force attackers into easily identifiable and restricted avenues of approaches.[49] These approaches make ideal sites for ambushes. Tyre is the one city in the region and most of the villages are located on hill tops amongst broken rocky hills, making each a natural defensible position.[50] The terrain itself made attacking into Lebanon difficult; however, Hezbollah further complicated Israel's problems with massive works.

Hezbollah had been preparing for a possible invasion since the day Israel pulled out in 2000. Hezbollah dug numerous tunnels and bunker systems to stockpile weapons to allow its fighters to ambush the IDF and then disappear. With help from North Korean advisors, the system of tunnels and bunkers connected key locations with command and control, included air conditioning and life support for soldiers, and included tunnels up to 25 kilometers in length.[51] The bunkers were buried deep and built to withstand attacks

from the Israeli air force and supported by communications cabling to allow commanders to pass information without compromise and to avoid jamming.[52] The bunkers included rocket launchers hidden behind trap doors and in some cases elevators that could raise a launcher, fire, and hide it again in minutes. Each village was turned into a fortified position, allowing anti-tank and ambush teams to attack approaching IDF soldiers and survive counter-fire. Hezbollah was prepared and provisioned for a sustained conflict.

Hamas attempted to replicate the efforts of Hezbollah; but, their terrain was not as favorable. Gaza is a flat, rolling strip of land 139 square miles in size, bordered by Egypt, the Mediterranean Sea, and Israel. Gaza is highly urbanized and sits on a dry flat coastal plain.[53] The large urban area and Gaza City provide most of the restrictive terrain for an approaching enemy, causing canalization along identifiable avenues of approach.

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Figure 5. An Explosion from an Israeli Strike in the Northern Gaza Strip

Source: David Shim, "40 Powerful Photos of the Conflict between Israel and Hamas in the Gaza Strip," *International Business Times*, last modified 06 December 2016, accessed 28 September 2017, https://www.ibtimes.co.uk/gaza-strip-40-powerful-photos-conflict-between-israel-hamas-1462766/.

Similar to Hezbollah, Hamas built numerous tunnels and bunkers; however, theirs are primarily used in smuggling in supplies because of the lack of external supply routes outside of Israel. Hamas booby trapped numerous houses within Gaza, with reports as many as one in three houses. They utilized mosque, schools, and hospitals to hide weapons caches and stashed supplies throughout the city.[54] This enabled fighters to conduct an attack, drop their weapons, walk to another location in civilian clothing, and pick up more weapons. Unlike Hezbollah, the tunnel system in Gaza is not as advanced.

Gaza is a heavily urbanized strip of land with Gaza City dominating the area. Gaza City consist of densely populated brick and masonry buildings, built in a middle-eastern style with adjoining walls, separated by narrow streets. The city center supports four to eight story complex buildings and has relatively larger roads and spaced out buildings. Most of Operation Cast Lead did not occur in Gaza City proper. The smaller urban areas feature the same brick and masonry buildings, averaging two to four stories with small windy roads and flat landscape. There is little to no substructures or raised highways. The urban areas are surrounded by flat to rolling desert landscape, ideal for rapid maneuver from many directions.

Mobility

Israeli failures in the Second Lebanon war and the lessons learned from it, followed by their successful implementation in Gaza, highlight the importance mobility provided by the Merkava A4. As noted by David Johnson in his Rand report, "Hard Fighting: Israel in Lebanon and Gaza," "Hezbollah also occupied prepared defensive positions in Lebanon's difficult hilly terrain and urban areas. Overall, this kind of adversary presented a qualitative problem that required joint, combined-arms fire and

maneuver."[55] Hezbollah's ability to utilize canalizing terrain and tunnels to establish ambushes and ATGM swarm attack greatly hampered Israeli ground maneuver. This mobility problem was demonstrated in earnest at the battle of Saluki. Twenty-four tanks of Brigade 401 crossed through the wadi as part of the division's attack, supported by infantry from the Nahal Brigade. The lead two tanks encountered a building collapsed across the wadi, blocking their path. When they attempted to find a bypass, a large buried IED exploded, collapsing the road. Swarms of ATGM fire rained on the tanks.[56] By limiting movement to key avenues of approach that supported the armored maneuver, the IDF had limited their use of the mobility and trapped themselves in an ambush.

Following the war, the Israeli government conducted numerous fact finding commissions and developed the Teffen 2012 plan. This five year plan was designed to restore the war fighting ability of the IDF. The plan stated that they needed to create "A decisive ground maneuver capability based on modern main battle tanks and other armored fighting vehicles."[57] The Israeli commanders after the war recognized the need for mobility in their operations. As one brigade commander emphasized, "Our advantage is our ability to move fast and our firepower. The tanks are now driving faster and using smokescreens- something they didn't use during the war."[58] This recognition of the need for mobility and maneuver shaped the interwar period.

By the time of Gaza in late 2008, the Israeli armored forces had studied and applied the lessons from Lebanon. When the ground combat phase started, the Givati Brigade rushed to Netzarim Junction to isolate Gaza City. They were preceded by armored bulldozers to smash through buildings and create alternate routes."[59] The ability of the Merkavas to traverse the rubble buildings and utilize the alternate avenues was

essential to the IDF avoiding Hamas ambushes. Finally, the sheer speed of the tanks proved to hinder Hamas ability to target the IDF. A Hamas communication intercepted during a counter-sniper operation stated that Israeli tanks were moving too fast to be targeted.[60] Whereas the lack of mobility proved deadly in Lebanon, the IDF fully utilized the Merkava to its fullest potential in Gaza.

The aspects of weight and size did not become issues in either Lebanon or Gaza because the IDF stayed clear of Gaza City and never reached an urban area in Lebanon.

Protection

Similar to mobility, protection provided by the Merkava can be fully understood through the lens of Lebanon, the IDF's lessons learned, and their incorporation into Gaza operations. In Lebanon, immediately after the kidnapping of the Israeli soldiers, the IDF sent a platoon from the Nahal force with a Merkava on a retaliatory attack on a local Hezbollah position. The tank was destroyed by a buried IED when it attempted to run over a Hezbollah hut.[61] The soft underbelly of the Merkava failed to protect the crew, resulting in all four killed. In the battle of Maroun al-Ras, the Golani Briagde engaged Hezbollah fighters in bunkers and tunnels. "Numerous IDF tanks were hit by long-range anti-tank missiles and wounded many of the tank crewmen."[62] The small Hezbollah anti-tank teams operating in swarms had caught the IDF off guard. This was repeated again at the Saluki Wadi. One Israeli soldier reported, "When the first tank was hit, we knew that the nightmare had begun. You should understand that the first missile which hits is not the really dangerous missile. The ones which come afterward are the dangerous ones."[63] The protection of the Merkava provided was normally able to survive a single ATGM; however, the swarm attacks meant that Merkavas had to survive numerous strikes. By the

end of the battle, 11 tanks had been hit by ATGMs. The design of the Merkavas minimized the casualties as only eight crewmen were killed and four of the infantryman.[64] What the Merkava provided that the poorly trained crews could have used was their smokescreen systems; however, they failed to do so.[65] The Merkava proved to be survivable but many the tanks used in the war were damaged and required repairs.

After the war, the lessons learned by the IDF highlighted the threat of ATGM fire. One of the brigade commander's comments stated, "We now understand that the threat of anti-tank missiles is 360 degrees."[66] This recognition of the ATGM threat led to several changes in both tactics and armament for the IDF. The IDF increased the purchase of the newer Merkava Mark IVs because "Properly deployed, the tank can provide its crew with better protection than in the past."[67] This comment underscores the importance of protection on the modern battlefield, especially in close quarters and urban combat where the enemy is able to close the distance with the tanks.

By the time of Operation Cast Lead, Israel had also changed tactics to accompany its new Merkava Mark IV fleet. When the armored force attacked, infantry and bomb dogs accompanied the tanks, to protect them from hidden explosives and to prevent enemy infantry from maneuvering on the tanks with ATGMs.[68] Keeping ATGMs and IEDs from being able to target the tanks, allows them to provide better support to the infantry units and decreases the risk they will be engaged in a vulnerable area of the tank. In order to also reduce the effectiveness of ATGMs when they did manage to hit the tank, the IDF reinforced their armored fleet with belly armor and more all-around armor after Lebanon.[69] These changes in tactics, equipment, and armament greatly increased the

survivability of the Israeli Merkava fleet and helped prevent losses in both crews and equipment during the Gaza campaign.

Firepower

The aspect of firepower is difficult to examine in the Second Lebanon war due to their abject failures to win any battle; however, the IDF's lessons learned from the war and their subsequent adjustments are apparent in Gaza. Prior to the Second Lebanon war, budget cuts and a focus on counter insurgency (COIN) had led to a significant diminishing of tank crewmen skills and familiarity with their weapons systems. The crews had used jeeps or dismounted to patrol Gaza and hadn't used their tanks in years.[70] This diminished skill was evident in the battles of Sukali and Maroun al-Ras when tanks were engaged by ATGM teams and failed to effectively return fire and utilize the systems the tanks provided. Following the war, changes in the IDF armored corps were implemented to focus on speed and firepower and trained in urban combat in tanks.[71] These changes and the greater competency were demonstrated in Gaza.

During Operation Cast Lead, the IDF conducted most of their attacks during the night. This allowed the tank crewmen to fully utilize their systems in the Merkava while taking advantage of the lack of night fighting skills and equipment of Hamas.[72] When the IDF did conduct attacks, they combined artillery and direct fires to support maneuver, heavily saturating suspected enemy positions with intense fire to prevent targeting of maneuver elements. The fire was so intense, many of the Hamas fighters simply abandoned their positions and withdrew, even when ordered to hold a position at all cost.[73] The primary lessons the IDF armored corps had learned from Lebanon of move fast and use fires, overwhelmed Hamas and rapidly turned the battle for Israel. "What the

IDF faced was a largely ruptured defense with an opponent knocked off balance."[74] Years of preparations and construction had yielded little success or effect for Hamas.

Summary

After fighting in both Lebanon and Gaza, Israel learned the value of tanks operating against an enemy dug into canalizing and urban terrain. The ability to maneuver rapidly over difficult terrain, engage a determined enemy, and survive against an onslaught of ATGM systems requires a tank, one that is prepared for the mission. One senior Israeli official also noted "The FCS [U.S. Army Future Combat Systems] notions concerning intelligence dominance replacing armor are disproved by our lessons. . . . [M]ore-balanced training is not enough. Strykers and MRAPs [mine-resistant ambush-protected vehicles] will not [with]stand a medium-heavy ATGM."[75]

The Israeli army in Lebanon had failed to capitalize on the mobility and firepower of the fleet of Merkava and had failed to meet any of their missions. Years of neglecting their armor corps had deteriorated their skills dramatically. Even basic systems designed to protect the tank and allow them to return fire and suppress enemy ATGM systems were forgotten. The saving grace in Lebanon was the protection the Merkava provided the crews. Despite the high number of tanks damaged by ATGM fire, few were destroyed and most of the crews survived. The protection of the Merkava proved invaluable. In Lebanon, the IDF fought mostly in canalizing terrain against fortified villages. Issues with tank mobility were not demonstrated and limitations of firepower were primarily due to training and not equipment.

In Gaza, the IDF was far better prepared and demonstrated the capabilities of the tank in an urban environment. Although the IDF did not enter Gaza City proper, large

stretches of Gaza are urban and densely populated. The IDF armor corps fully utilized the mobility of the Merkava, moving too quickly for Hamas to target, traversing through buildings and rubble made by the dozers, and rapidly advancing at night to their objectives. The fighting was intense and quick and the enemy crumbled before them, avoiding issues with mobility related to traversing and fighting in densely populated cities. The middle-eastern style of urban sprawl and relatively poor nature of the urban landscape meant there were few to no substructures to limit mobility. The overwhelming use of fires and maneuver allowed the tanks to quickly overwhelm the enemy, demonstrating the use of firepower. Overall, the rapid advance through Gaza, while avoiding the complex urban terrain of Gaza City, combined with firepower and night capabilities, led to a swift victory with few casualties. The IDF demonstrated why mobility, protection, and firepower of the tank are important in an urban battlefield.

Operation Iraqi Freedom Urban Combat

The third case this study will address is the United States Army and Marine Corps operations during Operation Iraqi Freedom. During the course of the war, the U.S. fought pitched battles during Thunder Run in Baghdad in 2003, Sadr City in 2004, Najaf and Fallujah in 2004-5, Sadr City in 2008, as well as maintaining a constant steady state operations in the urban areas of Mosul, Baquhba, Taji, Nasiriyah, etc.; these operations each included the use of the M1 series Abrams main battle tanks.

This case study will use both primary and secondary scholarly sources to include books and articles written by previous researchers and historians as well as the transcripts from the structured interview conducted for this study. This case study will be more expansive than the previous cases in timeframe and depth because it directly considers

the use of the M1 Abrams MBT use in urban terrain by U.S. service members. This case study will draw commonalities of the U.S. urban combat in Iraq regarding the strengths and weaknesses of the M1 Abrams, any improvisations the soldiers involved made to offset deficiencies in the tanks, and any performance anomalies specific to the tank. The study will consider the specifics of the terrain, enemy forces and equipment, review the physical characteristics of the M1 Abrams MBT, and examine how it performed across mobility, firepower, and protection.

Overview

On 19 March 2003, following the failure of the Iraqi President Saddam Hussein to heed the ultimatums of President George W. Bush, the United States launched Operation Iraqi Freedom.[76] The objective of the U.S. forces was to topple the Baathist Regime through attacks on the military and political targets that upheld their power. U.S. planners believed control of Baghdad was the lynch pin. Once the regime was removed, the allied forces could find and destroy all weapons of mass destruction.[77]

The coalition forces accomplished their objective by conducting a swift attack to Baghdad, bypassing and eventually capturing Basra, Al Nasariyah, As Samawah, An Najaf, Karbala, and Al Kut. Simultaneously, Special Forces and the 173rd Airborne Brigade linked up with Kurdish forces in the north and secured Mosul and Kirkut.[78] Elements of Task Force 1-63 Armor and 173d Airborne Brigade were flown to Kurdistan during Operation Airborne Dragon to support the Special Forces and Kurdish forces in Kirkut.[79] Once the Karbala gap was captured, 3d Infantry Division attacked to seize Baghdad and by 09 April 2003, with the toppling of the Saddam Statue in Firdos Square,

succeeded. President Bush announced an end to major combat operations from the deck of the USS Abraham Lincoln that afternoon.[80]

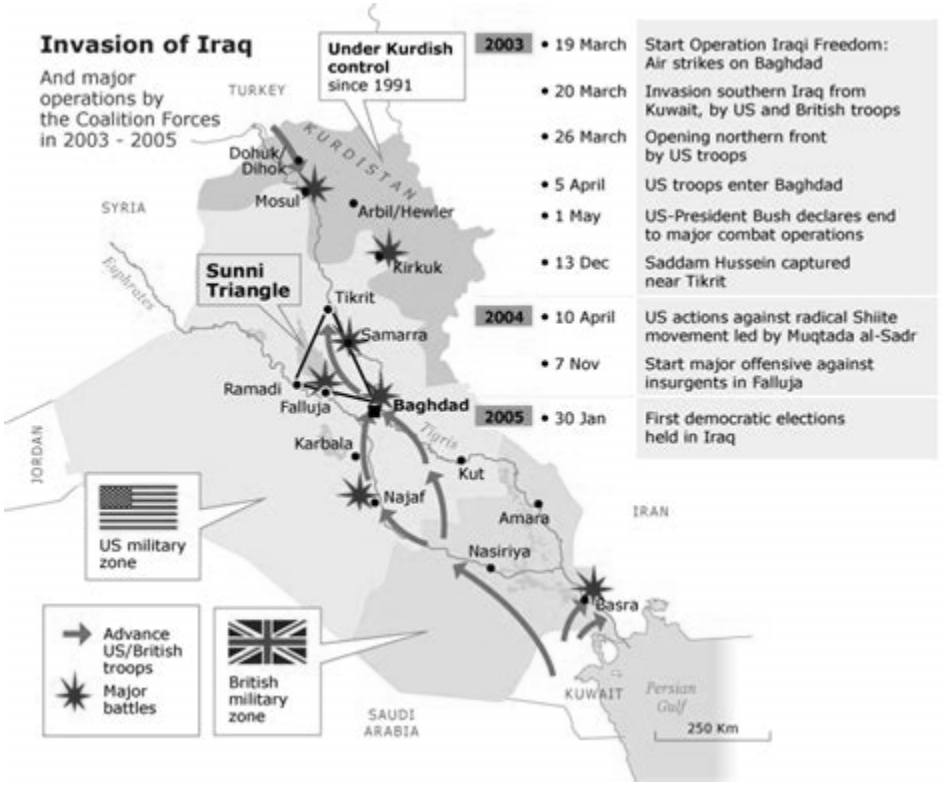

Figure 6. Operation Iraqi Freedom Overview, 2003-2005

Source: University of Memphis Libraries, "From Active Duty to Veteran: Honoring Military Service in America: Gulf Wars," University of Memphis, last updated 19 May 2017, accessed 28 September 2017, http://libguides.memphis.edu/c.php?g=131493&p=899585/.

Following the symbolic victory, coalition forces began consolidating in Sunni and former Baathist strongholds, attempting to capture key leaders from the party, find and destroy the weapons of mass destruction, and anticipating Sunni and Iraqi Army loyalist resistance would remain in the Sunni regions.[81] Key cities that were occupied included

Baghdad, Ramadi, Fallujah, Taji, Samarra, Tikrit, Baquhba, Kirkut, Mosul, An Najaf, and Al Kut. The British armored division secured Basrah.[82] With the exception of the northern city of Mosul, mechanized forces utilizing the M1 Abrams MBT or British Challenger were now located in and conducting operations in every major city of Iraq.

The initial celebrations and calm that followed the tumbling of Saddam's regime was short lived. With the debaathification policies putting nearly all Iraqi politicians, police, and military out of jobs, and remnants of Saddam loyalist still fighting a guerilla war, insurgent activity began to grow.[83] During the transitions of U.S units in Iraq, Sunni insurgents in Fallujah publically hung U.S. contracted truck drivers. This led to the first major campaign since the war. The USMC attacked to secure the city with two battalions in Operation Vigilant Resolve.[84] Shortly thereafter, the rhetoric of Muqtada al Sadr led to the interim government calling for his arrest. This led to numerous uprisings in many of the Shia cities of Southern Iraq as well as large scale attacks on U.S. forces operating in Sadr City, smashing the image of a peaceful transition to power. The coalition launched Operation Iron Sabre with 1st Armor Division, the methodical clearing of An Najaf, Kufa, Al Kut, and Karbala. Both operations quelled initial unrest but lead to increased presence and insurgent activity.[85]

As the insurgency continued and the Sunni and Shia paramilitary forces began to openly fight to shape the political battles, more large scale armored clearance missions became necessary. 4th Infantry Division conducted clearance operations of Samarra in February 2004. In November 2004, the USMC and elements of 1st Infantry Division cleared Fallujah a second time.[86] By January of 2007, the U.S. conducted the "surge," and sent an additional 20,000 U.S. soldiers to Iraq to end the cycle of violence with

systematic clearances of Al Anbar province and Baghdad. Again, the U.S. forces utilized the M1 Abrams MBT in numerous urban fights against determined enemies.

Equipment

During the attack on Baghdad, the 3d Infantry Division faced off against the remaining Republican Guard divisions of the Iraqi Army, paramilitary forces, and armed civilians.[87] The Republican Guard divisions were the best equipped of the Iraqi Army and had T-72 tanks, BMPs, SA7 anti-air missiles, 2S6 artillery pieces, and an assorted array of Russian made machine guns, AK-47s, and RPGs. Prior to the ground forces entering the city, aerial bombing and the attacks on the outskirts of Baghdad and the Baghdad international airport had destroyed much of the heavy weapons and armor support, leaving the dismounted infantry to do the bulk of the fighting[88].

During the campaigns in Fallujah in 2004 and much of the insurgency fighting across the Sunni regions of Iraq, the enemy forces consisted of insurgents and guerilla forces with a backing of hardline foreign trained terrorist. Their array of weapons consisted of AK-47s, Russian made machine guns, RPG-7s, Improvised Explosive Devices made from ordinance raided from war stocks or found after the war, and numerous rockets and mortars of various calibers. The Sunni insurgents used suicide bombers and vehicle borne IEDs (VBIED) on a regular basis.[89] The fighters wore civilian clothing, allowing them to blend into the population, and had no formal command structure for targeting, operating in small teams. Sunni religious zeal and belief in the U.S. as crusaders led to a willingness of hardliners to fight to the death.[90]

The campaigns against Shia strongholds, mostly connected to Muqtada Al Sadr, also had similar weapons and command structures as the Sunni insurgents. These forces

were backed by Iranian support and equipped with similar Russian produced weapons and RPGs. The largest difference between the Shia insurgents and the Sunni insurgents was the use of suicide bombers and VBIEDs, tending to use IEDs and snipers instead. These forces fought against U.S. forces in the prominently Shia southern regions of Iraq and Baghdad.[91] Shia fighters were more prone to hit and run and swarm tactics and generally didn't want fight to the death.

The U.S. Army and U.S. Marine Corps both utilized a wide array of weapons systems in Iraq and armored vehicles, aircraft, and artillery. The standard U.S. soldier was equipped with U.S. made small arms and machine guns as well as TOW-II, AT-4 and Javelin anti-tank systems. The U.S. only had one tank in service at the time of Iraq, the M1 Abrams MBT with several variants still in use at the start of the war.

The M1 weighs 63-65 metric tons, provides advanced optics to include independent thermal viewers for both the commander and gunner, is equipped with 120mm smoothbore main gun, .50 Cal Machine Gun, two 7.62mm M240 Machine Guns, and personal small arms. The tank is 24'4" ft.in in length with the barrel extending another 6 feet to the front, 11'11" ft.in wide, and 9.5 feet in height. Because of the 1500 horsepower turbine engine, it is capable of accelerating up to 42 MPH in a matter of seconds. It has 19 inches of ground clearance.[92]

Terrain

Although each city in Iraq had distinct features and terrain, the general makeup of the cities remained the same. The city layouts were random. There were no zoning laws and residential, business, and industrial buildings are interspersed. Residential neighborhoods have narrow streets lined with walled buildings built adjoining the rear

and adjacent houses. Each house had a courtyard overlooked from the roof and upper floors. Each building was generally brick and mortar construction, and one to two stories in height. The streets were canalizing with no space between the outer walls of the houses and the street.[93] Large highways ran through the center of the cities, providing wide avenues of approach and clear fields of fire. In older areas of the cities buildings were closer together, the roads generally dirt and in a much more haphazard pattern. Each city generally followed a river, providing the lifeblood of the desert landscape, and had several bridges in various states of repair crossing key points.[94] Major roads or intersections within the cities would often be home to outdoor markets, a sprawling area of shops and mobile stands that would extend into the roads, often congesting or completing blocking traffic in those areas. During normal operations, these areas were filled with civilians walking the streets and in high intensity combat, the booths and stands created obstacles, reducing road widths and providing cover or concealment.[95]

The larger cities, such as Baghdad, had areas with taller buildings, 4-6 stories tall, or occasionally eight or more stories. Sadr City, a poorer neighborhood in Baghdad, is unique in that the average building height was three to four stories, and 2.4 million people live in an area 39 kilometers squared.[96] Unique features for each city provide difficulty for attacking forces. Fallujah had a raised rail line on the northern side of the city, creating a natural barrier.[97] Sadr City was bordered on the southern end by route Pluto, a split highway with a canal in the center that could only be crossed at major road bridges.[98] These unique features independently affected operations in the respective cities and also shaped daily patrols by the coalition forces across Iraq.

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Figure 7. Sadr City during Dust Storm

Source: Haley Richardson, "Baghdad Gets First Female Mayor in 1,250-Year History," *Newsweek*, 25 February 2015.

Mobility

Reviewing the aspect of mobility of the M1 Abrams MBT in Iraq, several strengths and several weaknesses were present. The critical strength the M1 Abrams brought to urban warfare was its ability to traverse difficult terrain and push through the mortar-brick walls used in Iraq. This ability is resident in the tracked nature of the vehicle. In the battle of Fallujah, the USMC used the M1 Abrams as a battering ram to punch holes in the outer courtyards or walls of buildings to provide alternate entry points for the infantry. The bombardment of the city had created debris and wreckage

throughout the city that the tanks were able to easily push through or drive over.[99] There were concerns about throwing track and becoming disabled while under contact; however, the tank maintained the capability to do so. As one armor captain who fought in Baghdad stated, crossing a burning car or palm tree could be done, but he didn't want to become disabled by a thrown track while under fire.[100] The mobility of the armored force was so great that the USMC forces following through the breach expected to have several more hours before they started operations and fell behind.[101] Captain Glass, Commander of C/3-8 Cav in the battle of Fallujah, utilized the plows on his tanks to proof lanes in the breach to ensure trafficability of the route.[102] In the battle of Sadr City in 2008, Captain Moore's tanks were able to push through or crush barriers being erected by insurgent forces attempting to block U.S. advances.[103] While operating on the main supply routes, the tank enjoyed complete freedom of maneuver. When entering the more built up areas of cities, the M1 Abrams was still capable of traversing the terrain in most circumstances. As one company commander in Baghdad referring to his sector stated, "There really wasn't anywhere the tank couldn't physically go if you wanted to bad enough. It was a matter of if you were willing to cause damage to the street and vehicles parked in the way."[104]

Although the M1 Abrams proved to be quite versatile in its ability to traverse difficult terrain in Iraq, its mobility was still limited. During interviews with U.S. Army and USMC Armor officers who served on M1 Abrams in Iraq, five of nine officers stated that roughly one third of their Area of Operations (AO) was not accessible by the M1 Abrams. Furthermore, two officers served in AOs where more than half the city was inaccessible. These were due to the width of the tank and its inability to fit down the

roads.[105] While discussing his company's attack into Fallujah, Captain Glass stated, "it took a little bit of time to maneuver through the narrow streets; and sometimes we couldn't find how to get through because the road wasn't clear enough."[106] Captain Moore's attack into Sadr City also detailed several instances of having to close down to a single file in order to traverse narrow roadways.[107]

The sheer width of a heavy tank in an urban environment provides challenges in combat. One Armor officer interviewed discussed having to make turns at key intersections because the tank was too wide to turn in the roads, and if it broke down, bringing in the even larger recovery vehicle would become problematic.[108] Eight of the nine interviewed officers felt the size of the M1 Abrams was a weakness in urban combat. The general lack of a determined enemy in Iraq enabled the successful operation of the M1 Abrams in the tight spaces. The tanks often caused maneuver damage while attempting to traverse the city, destroying power lines, knocking down walls, and tearing up the roads. Most of the officers stated that they had developed methods to offset this weakness, either by using smaller platforms, identifying which roads would not support the M1's maneuver, or modifying the role of the tanks in that operation.

The size of the M1 Abrams was not the only weakness noted by the interviewees. Six of the nine also stated issues created by the weight.[109] Most of the officers stated that there were bridges or embanked roads in their AO. The largest bridges generally supported the M1's weight; however, the smaller bridges, and embanked roads only supported limited movements. Two officers had roads deteriorate from use or destroyed by insurgents, thereby limiting their ability to access parts of their area of operations.[110] In the counter-insurgency role, the weight of the tank created further issues. The first

tanks into Baghdad destroyed much of the underground sewage system in Eastern Baghdad. This created pooling of sewage in the streets. The pooled sewage both created ill sentiment that the U.S. had destroyed their services without fixing them, and even created areas where tanks would become mired in mud.[111] This ill sentiment helped fuel Muqtada Al Sadr's rise to power. The desert based climate and limited Iraqi infrastructure prior to the war, meant that there was little in the way of sub-terrain in the cities other than sewage lines; however, the weight of the tank was enough to destroy the underground pipes. A more developed sub-terrain could have led to further problems.

Protection

The biggest strength of the M1 Abrams MBT in urban combat is its protection. Every officer interviewed agreed that the M1 Abrams provided excellent protection to both the vehicle and the crew. In all the interviews, only crewmembers who were exposed above the turret were ever injured or killed from enemy contact.[112] This trend is supported by Captain Moore's AAR for the battle in Sadr City, with tanks taking more than a dozen RPG rounds but did not stop the tanks or injure crews.[113] Lieutenant Colonel James Rainey's experience differed slightly. During the battle for Fallujah in Operation Al Fajr, whether through chance or intentional targeting, RPGs impacted the crew periscopes and blowing glass into the turrets.[114] Overall, nearly all of the RPGs were fired from the front and front flanks of the tanks, striking the thickest armor. There were RPGs that penetrated the armor in Fallujah, when impacting the top of the tank or the rear of the tank, which did cause some U.S. casualties. Captain Pete Glass described one tank appearing to explode and burn; however, the RPG penetrated the top armor and set off a thermite grenade, but failed to cause significant damage.[115]

IEDs were also problematic but rarely failed to stop the tanks or kill the crew. Captain Glass stated that "it's difficult to differentiate when you're buttoned up between an IED explosion and an RPG, unless you get out afterwards to check . . . but our tanks had taken so much battle damage . . . we weren't able to tell."[116] Similarly in the 2008 battle of Sadr City, David Johnson notes that "heavy armor proved important in the fight, providing firepower and an ability to withstand hits from IEDs and RPGs." This contrasted with the experience of the 1-2 Styrker Cavalry Regiment, who lost six Stryker vehicles in less than a week.[117] The M1 Abrams was designed to survive enemy main gun rounds from the frontal armor and its ability to do so was proven time and again in Iraq. Training and Doctrine Command conducted an after action review of the 1st Cavalry's deployment to Iraq in 2004. In their analysis, 35 M1 Abrams sustained damage requiring depot level repairs but were still operating, "demonstrating outstanding survivability."[118].Numerous attacks against the tanks failed to kill the crews or damage the tanks enough to stop their operation.

However, the tank was designed to withstand frontal attacks and to fight buttoned up, not the 360 degree fight of the urban landscape. The close quarters of urban combat required loaders and tank commanders to stand up out of the turret in order to see the deadspace near the tank or to identify enemy personnel located nearby or above the tank. Fully a third of all tank crewmen killed during 1st Cavalry Divisions deployment were loaders standing out of the hatch.[119] The tank commanders and loaders from C/2-37 Armor's attack into Sadr City in 2004 were all wounded from shrapnel or small arms while operating outside of the hatch. The importance of their exposure was a critical factor in the decision of Captain Moore with which tank commanders were buttoned up

and which were exposed.[120] It was a choice between situational awareness and protection based on greater need at each position of the battle.

Furthermore, six of the nine armor officers interviewed supported these findings, listing the top, bottom, and rear of the tank as weaknesses in the protection aspect of the M1 Abrams. Two others did not list the top armor as the area's they operated in did not provide a top down threat. Several of the officers noted RPG attacks, grenades, or parachute grenades from upper story levels against their tanks.[121] The next biggest threat was IEDs. One captain explained that the insurgents had some luck with detonating IEDs that would strike the fuel cell behind the number one skirt on the M1 Abrams, causing the fuel to ignite, damaging or destroying several tanks. Three other officers noted the threat of underbelly IEDs and the damage and destruction of M1s caused by large buried IEDs. This was the number one threat to tanks in OIF.[122] Overall, the M1 Abrams MBT is extremely well protected from the frontal arc as it was designed for tank on tank combat; however, the nature of the urban environment caused the weaknesses of the underbelly, turret top, and rear to become more significant. The need for crewmembers to expose themselves during maneuver or to identify enemy forces in upper levels also caused protection lapses as the crews were the most vulnerable.

Firepower

The final aspect the M1 Abrams brought to the urban fight was firepower. This included the ability to identify targets, engage targets, and destroy difficult targets. As noted by the New York Times columnist Alex Berenson during the battle for Fallujah, when the marines identified an enemy dug in, they'd call for the tank. The responsiveness of a tank is far greater than trying to bring in aircraft and would prevent the need to send

infantry to clear the building.[123] Through firepower, tanks also provided protection to the infantry units on the ground nearby. Sgt. Catagnus notes in is article that "By far the best two supporting arms used were tanks and CAAT [Combined Anti-Armor Team]... The battle would have been incredibly bloodier if it hadn't been for tanks and CAAT."[124]

One reason for this is the thermal imaging sites on the tank enabled it to identify targets quickly and easily. When engaged by snipers, the thermal sites highlight the position and allow the U.S. tank crewmen to engage and destroy their position.[125] Captain Moore also noted that the enemy didn't understand this capability when fighting in Sadr City. The Mahdi militia would conduct drive by attacks on their position at night, easily being engaged and destroyed by his tanks.[126] One Armor officer harped on the impressiveness of the sights, being able to zoom in on faces and nametags at 2000m.[127] This ability to identify and engage targets greatly benefited the M1 crews in Iraq. During Captain Glass's attack into Fallujah, they would use their sights to identify caches and enemy positions, destroying them with main gun as they continued to advance ahead of the marines, making the actual clearance mission for the Marines easier.[128]

The second part of firepower that enabled the U.S. tank crewmen in Iraq was the weapons systems themselves. While conducting his attack Captain Glass would engage suspected IEDs with the coax machine gun, causing them to explode prematurely, rather than wait for EOD.[129] Captain Glass also noted that the HEAT round provided excellent room clearance and made holes large enough for ground forces to attack into a building without having to enter through the doorways the enemy expected.[130] Beyond the ability to kill the enemy with the weapons, the main gun also had a morale effect on the enemy. Captain Moore noted that whenever the main gun would fire, the enemy would break and

run from combat.[131] In the less kinetic steady state fights, four officers mentioned that when the M1 Abrams was around, the enemy would not attack.

As powerful as the weapon systems are on the M1 Abrams, its weaknesses were also exposed in Iraq. The chief complaint by seven of the officers interviewed and also noted by Captains Moore and Glass in both Sadr City and Fallujah, was the inability to elevate the weapon system. Captain Class stated that they would have to trail vehicles behind to provide fire into upper floors above and near the lead tanks.[132] Captain Moore stated that they were unable to engage enemy targets close into the tanks with the main gun system. This was created by the lack of standoff between the tanks and the inability to elevate the main gun high enough. They also had issues with engaging enemy to the flanks because the barrel of the main gun couldn't be turned toward the enemy due to the narrow streets limiting mobility of the turret.[133] Captain Moore's crewmen had to utilize small arms for close in engagements or engagements too high off to the flank of the tanks, negating the most powerful aspect of the tank. Moore also realized that the burning obstacles the enemy was placing in the roads prevented the thermal sites from distinguishing targets.[134] Overall, the firepower aspect of the tank performed well in Iraq; however, key weaknesses were identified in the ability to identify targets or to bring the weapons systems to bear on those targets.

Summary

The M1 Abrams MBT mobility, protection, and firepower in Iraq were decisive in the ability of the U.S. forces to conduct both counter-insurgency and urban combat. The mobility the M1 enabled the U.S. forces to bring tanks to most locations and environments. This allowed the U.S. Army and USMC to support their forces in every

major urban fight and provided reliable armored forces in dangerous areas. However, the sheer size and weight of the M1 Abrams also proved to be problematic. Damage to substructures and cities, being too wide to fit down many streets or limiting the ability to maneuver if they could get into the streets proved problematic, especially during the high intensity periods. The weight limited avenues of approach and damaged roadways.

The protection aspect of the tank was incredible. The enemy rarely was able to stop an M1 from completing its mission and as Alex Berenson noted in his article, "Army's tanks and Bradley fighting vehicles reduced American casualties while demoralizing the insurgents, who could not stop the heavy armor."[135] As powerful as the protection of the M1 is, the requirement of the crew to leave that protection to maneuver the tank is still problematic. Furthermore, the M1 as designed to withstand attacks from the front, which the insurgents generally were willing to comply with; however, when engaged from the top, bottom, or rear, the M1 experienced more damage. Eight of the nine interviewed officers agreed that had the enemy force in the urban Iraqi fight been better equipped or more tenacious, these vulnerabilities would have been felt more.

The firepower of the M1 also proved to be extremely capable, when the enemy could be targeted. The incredible sights of the M1 enable the crew to identify and engage enemy targets at ease and the main gun and coax machine gun's accuracy made short work of the enemy. The inability of the main gun to elevate high enough or depress low enough was felt in the high intensity combat situations faced in Iraq. Overall, the M1 proved to be quite capable in the Iraq urban environment with regard to all three aspects of mobility, protection, and firepower.

U.S. Marine Corps Amphibious Operations with the M1 Abrams

The fourth case for analysis is the use of the M1 Abrams main battle tank by the United States Marine Corps and their ability to conduct amphibious assaults. The USMC is a much smaller service component than the U.S. Army, with only three tank battalions consisting of a total seven tank companies.[136] This small element forces the USMC to adopt the same equipment as the U.S. Army because they cannot afford independent development of separate combat platforms and supply chains with a few exceptions. They often receive equipment from the U.S. Army that has been replaced with newer models. This is especially true of the armor force of the USMC. The current fleet of tanks were transferred from the U.S. Army when it upgraded its tanks from M1A1 to M1A2s. As such, any purchase of a new tank by the USMC is necessarily limited to the U.S. Army fielding of the new tank. This also means that new tank purchases for the U.S. Army can achieve cost efficiencies by planning for USMC adoption of the platform.

Therefore, this study will examine the strengths and weakness of the M1 Abrams platform with regard to mobility, firepower, and protection during use in amphibious operations. This is a mission unique to the USMC in how the M1 Abrams is employed to date. Ground combat and urban operations of the USMC would not be significantly different form the U.S. Army and covered by the remainder of this study. This case study will describe the USMC's doctrine for amphibious operations, the employment of the M1 as part of the ground force, and then review the specific attributes of the M1 Abrams in regards to mobility, firepower, and protection during the amphibious operations.

Doctrine

The United States Marine Corps operates forward sea based air and ground tasks forces capable of executing missions in support of national command objectives on short notice anywhere with nearby access to the sea. This ability and national requirements uniquely shapes the doctrine of the USMC and generates a different set of requirements for the equipment and training of the USMC forces. The four primary manuals that drive how the USMC operates in regards to amphibious operations are the *Marine Corps Operating Concept*, JP 3-02*, Amphibious Operations*, *Expeditionary Force 21*, *Seabasing, and Ship to Objective Maneuver*.

The *Marine Corps Operating Concept* describes how the USMC envisions its employment to meet the various missions it is required to perform. The USMC described its operating environment as the littorals, or the sea and land areas within 20 miles of the coastlines with the possibility of expanding their reach to up to a 100 miles or more from the sea. These portions of the planet include the "growth of crowded, poorly governed, or lawless areas, particularly in and around the world's littorals."[137] The manual described six primary roles for the forward based forces to execute. The first role is to provide a "credible and capable presence that gives national authorities immediate response options."[138] In this role, the strength of the forward deployed force and the combat power it can bring to bear against an enemy is paramount. This includes the capability of the armored force it can employ. The fourth and sixth roles are the ability to seize and secure lodgments or forward expeditionary advanced bases. Both of these missions require the forward deployed forces to use amphibious operations to seize and control critical locations such as ports, airfields, etc. Finally, the third role, to operate in a contested

environment, may require marine tasks forces to capture or destroy anti-access area denial sites that limit the ability of the task force to maneuver to key locations at sea.[139] Each of the mission sets relies on a ground force capable of seizing and securing ground and sustaining operations until reinforcements can be brought forward. The support of armored forces is vital to their success and ability to withstand counter-attacks.

The second USMC doctrine is *Expeditionary Force 21*. This document laid out where and how the USMC will forward base and maintain forces, posture, organize, equip and train. This document laid out the requirement for one third off the USMC to operate deployed forward. These forces must be "Light enough for rapid response, Heavy enough to prevail in the littorals."[140] The document set the importance of rapid seizure of critical locations and then laid out how the USMC will task organize to be able to accomplish their mission set. The document established the concept of the Marine Expeditionary Unit (MEU), and Amphibious Readiness Group (ARG) as the base element of the forward presence.[141] These forces are battalion sized rotational units that are self-sustaining for short periods of time. This document underscored the importance of a tank in support of the MEU being easily transported both on the ARG and landing craft as well as survivable against a determined enemy until relief can arrive while providing the firepower to the Marine Task Force.

The third doctrinal reference for the USMC is Joint Publication [JP] 3-02*,* *Amphibious Operations*, published in July 2014. JP 3-02 described amphibious operations as the "use of maneuver principals to transition ready-to-fight combat forces from the sea *to the shore in order to achieve a position of advantage over the enemy," and "gaining* access where the enemy least expects it."[142] The manual stressed the need

for “rapid, focused, and unexpected actions” and “projecting and apply combat power at precisely the most advantageous location and time.”[143] Finally, when describing amphibious assaults as “the establishment of a landing force on a hostile shore,” the manual instructed that a “swift introduction of sufficient combat power ashore to accomplish [assault force] objectives” to accomplish seizure of objectives such as ports, airfields, or advance bases.”[144] Key to each of these statements was the need for the rapid build-up of organized forces and swift movement to objectives. This required any tank supporting the operation is capable of both being transported quickly and in sufficient numbers to the shore and the ability to transition across the ground after delivery.

The final doctrinal document to note which the USMC utilizes for guidance in amphibious operations is *Ship to Objective Maneuver* (STOM) revised May 2011. STOM sought to shape how the USMC viewed amphibious operations as a single mission from start to completion, instead of treating the seizure of the beach as one mission and the follow on objective as another. Under STOM’s central idea, “amphibious forces leverage resources in all domains air, sea, land, space and cyberspace to gain area control with maximum speed and effectiveness.”[145] The first tenet of STOM is that it “seeks to remove the transition at the water’s edge. Exploiting significant improvements in the speed, range, and command and control; . . . leveraging superior mobility.”[146] Both of these statements reflect the requirement for a tank capable of rapid transition to the shore in sufficient numbers to enable rapid movement to follow-on objectives. This rapid buildup of combat power is again emphasized in chapter 3: Hostile Environments, stating that “the speed of combat power buildup at the point of contact . . . may be essential to accomplishing national objectives,” as well as “maneuvering combat units ashore in their

fighting formations, and in sufficient strength to strike directly at the point of decision."[147] The manual continued to stress "self-contained combined arms teams," "rapid movement of this force inland," "high-speed amphibious mobility." Combined, it is clear that the USMC required any tank it operates to be easily and rapidly moved in sufficient numbers to achieve the mission objectives.

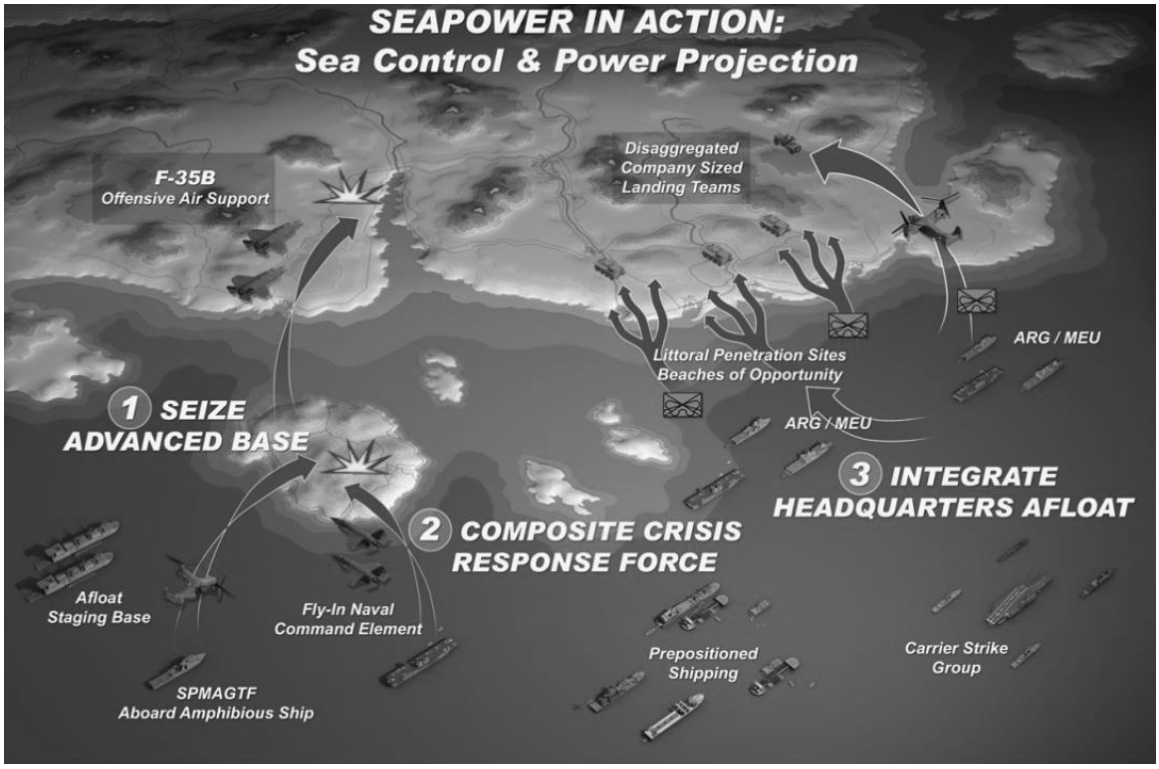

Figure 8. Marine Doctrine Graphic

Source: U.S. Department of the Navy, *Expeditionary Force 21* (Washington, DC: Government Printing Office, March, 2014), 22.

The USMC conducts amphibious operations training on an annual level, with four named exercises. These exercises are conducted either annually, or biannually in conjunction with partner nations. Operations Ssang Yong, Bold Alligator, and Rim of the

Pacific are conducted annually in most years, while Dawn Blitz is biannually conducted. With the exception of Bold Alligator, each is a multinational operation. These operations test different capabilities and requirements for the USMC with respect to amphibious operations. Ssang Yong 13 tested the trident pier system and the deployment of ten M1 Abrams.[148] Ssang Yong 16 tested the STOM model, deploying a tank company to the shore and into a range training exercise.[149] These exercises, their AARs, and the interviews with USMC officers provide insight into how the M1 Abrams performed in respect to mobility, protection, and firepower in amphibious assaults.

Mobility

Mobility of the M1 Abrams MBT with regard to USMC use in amphibious operations can be broken down into two distinct subsets, transportation to the shore, and operations on the shore. All the Marine Corps officers interviewed for this study whole heartedly agreed that the mobility of the M1 Abrams once it reached the shore was unmatched. As one field grade officer stated, "not only if you can get it ashore are you good, but it's also good for pulling other stuff out that's stuck."[150] Another Marine officer noted that the M1 Abrams is the only vehicle that can come ashore with a plow and prepared to breach obstacles.[151] Although the weight of the tank could be an issue in certain soil areas, another marine noted that any consideration for beach soil and the weight of the tank would be taken into account prior to deciding where to conduct a landing, eliminating the issue. This might be problematic in a hasty assault; however, the Navy has beach and soil charts on all likely landing sites. Where the marines had seen issues with the mobility of the M1 Abrams ashore was in the ability of smaller Pacific

countries to support the tank along infrastructure between the ports and the training areas. The size and weight would exceed the capabilities of the roadways.

A related aspect of the mobility of the M1 Abrams MBT ashore, is the logistics of supply for the tank. One Marine officer noted that the landing forces come ashore with one day of supply.[152] This necessitates the rapid resupply of the tank as the onboard fuel capacity is only four to eight hours of operation without resupply. With every asset of the landing force competing for space on the limited landing craft, the ability to bring additional fuel and oil forward to continue fighting the M1 Abrams can be problematic. Without the requisite supplies, the tank is limited in its operational use.

The other aspect of the M1 Abrams mobility, and the one every marine stressed, was its transportability. The USMC currently uses the Landing Craft Utility (LCU) and the Landing Craft Air Cushioned (LCAC) as the primary transportation methods to disembark non-aquatic capable equipment to the shore. This includes the M1 Abrams, the LAV-25, the artillery, logistics elements, etc. Theoretically, the LCU can carry two M1 Abrams; however, the age of the fleet has reduced that capability to only one. Similarly, the LCAC can also only carry one M1 Abrams. The LCAC has the ability to "pre-boat" equipment, or the ability to store the equipment on the LCAC before it turns on so that the first load is already prepared once operations start. Because of the weight of the M1 Abrams, the LCAC cannot support pre-boating.[153] The LCAC provides the advantage of moving quickly over the water and delivering its cargo directly onto the shore and is capable of being launched over the horizon, more than twelve nautical miles from shore. The LCU is much slower but can hold a larger load while still maintaining the over the horizon launch. The issue presented by the LCU is the amount of time each lift requires

to travel to and from the shore.[154] Given that a normal MEU will have two to four landing craft of any type and the number of competing requirement for all equipment needing to be brought ashore, committing to carrying one tank to shore is a costly choice for the Marines. Depending on which platforms the MEU has, committing the M1 Abrams to deploying ashore will either require the piecemeal delivery of an M1 unit or prevent any other supporting arms from be landed. This was highlighted in operation Ssang Yong 14, when the loss of LCUs prior to the start of the exercise limited the number of craft to deploy and necessitated that not all the combat platforms would actually be landed.[155]

Furthermore, every Marine acknowledged that because of the vulnerability and lack of numbers of the landing craft, the M1 Abrams could not be used in the amphibious assault.[156] The first wave of marines would have to secure the beach without the support of any non-amphibious vehicles. The tank is the one capability that cannot be offset. Of the other vehicles that would go to shore, the LAV-25 is a scout vehicle that would be used once the marines leave the beach. The artillery can be replaced by naval bombardment until the beach is secure. What the Marines lack in the assault are armored vehicles that can survive contact and provide firepower at points of friction, something the tank would provide if it could be delivered, as was the case on D-Day 1944.

The other point of contention each Marine officer noted was the amount of space the current M1 Abrams requires on the ARG. Because of the size and weight of the M1 Abrams, and the large logistical tail each platoon, the tanks on the ships require a disproportionally larger footprint or "cube space" on the ships.[157] The marines compared one tank platoon to an entire LAV-25 company or Amphibious Assault Vehicle platoon

with nine vehicles. One Marine field grade officer also mentioned that this was becoming more of an issue as the modern ships replacing the fleet were becoming smaller in space and the combined weights of all Marine vehicles were forcing the Marine Corps to reexamine ship requirements.[158] Often, the MEU commanders will choose not to bring tanks on the mission unless they believe they will absolutely require them because of the size and weight issues.

Protection and Firepower

With regard to protection and firepower, all of the Marine officers interviewed agreed that the M1 Abrams MBT was unmatched, once you got it to shore. The sights provided the M1 with the ability to identify targets with precision that no other vehicle in the USMC can. The main gun and supporting weapon systems provide an immense amount of firepower that is more than capable of destroying any target identified and the heavy armor package of the tank allows it to survive numerous strikes from enemy anti-tank weapons systems. Several Marines discussed their experiences with the tank in Iraq to relate the protection and firepower of the M1 and reinforce the idea that once the tank gets ashore, it is a powerful weapon system.[159] During the Bold Alligator 16 exercise, A.M. Delgado noted, "Fighting against a near-peer competitor requires light infantry to incorporate heavy armor and mobility gaining assets to support offensive actions. Without the required armored assets to provide shock, firepower, mobility and survivability, decisive offensive effects are difficult to obtain."[160]

Summary

The M1 Abrams MBT has proven to be both a capable and survivable tank for use by the USMC during its operations over the last few decades. Where the M1 Abrams has shown a mismatch with USMC doctrine is in its transportability and logistical requirements. If the Marine Corps wants to be able to project and deploy combat formations in rapid succession to key locations in a timely manner in order to facilitate rapid movement to the objective, the size, weight, and heavy logistical requirements of the M1 Abrams do not facilitate this mission. Requiring multiple turns of limited lift assets to deploy, reducing the ability of the fleet to transport other assets because of the cube-space required, and the inability to be landed when the amphibious assault is most vulnerable greatly reduce to effectiveness of the M1 Abrams to meet the needs of the updated doctrine of the USMC. A lighter, smaller tank that provided similar protection and firepower would greatly enhance the USMC's ability to conduct its mission.

Historical Case Study Comparison Analysis

The first level of analysis completed by this study was the independent examination of each four cases related to the use of tanks in urban or amphibious environments. From the collected information this study extrapolated common themes related to the performance of tanks in these environments. It determined commonalities regarding the strengths and weaknesses of the tanks involved in each case study, and examined how they performed across the aspects of mobility, firepower, and protection.

The second level of analysis will examine the case studies as a set of related cases. From the themes in each case, this study will identify commonalities across the cases related to the performance of tanks these environments. This analysis answers what

strengths and weaknesses tanks had in these environments, and how soldiers have overcome the weaknesses in the past. These common themes will be examined in relation to the issues of mobility, firepower, and protection the tanks provided to the case studies. The strengths and weaknesses from the related cases will then be used to develop the requirements for tanks to operate effectively in the historical case studies.

Mobility

In the first four cases, this study examined three different tanks, the M48A3 Patton, the Merkava, and the M1 Abrams. The three tanks had similar characteristics with respective weights of 45 metric tons, 65 metric tons, and 63.5 metric tons respectively. Each tank is roughly 12 feet wide and stands between 9 feet and 11 feet tall. The three tanks are all between 21 and 26 feet long. The Merkava and M1 barrels extend 4 feet and 6 feet in front of the tank respectively. The M48 is the outlier with a barrel extending 9.5 feet in front of the tank. The M48A3 Patton is the only tank with a medium weight. With the three tanks having similar characteristics, their performance within their environments is easily comparable. See Table 1 for characteristics.

Table 1. Characteristics of Tanks Utilized in the Case Studies

	M48A3 Patton	Merkava A4	M1 Abrams
Weight (Metric)	45 tons	65 tons	63.5 tons
Height	10’10” ft.in	9’ ft.in	9’5” ft.in
Length	20’10’ ft.in	24’4” ft.in	25’11” ft.in
Barrel Ext	9’7” ft.in	3’11” ft.in	6” ft.in
Width	11’9” ft.in	12’2” ft.in	11’11”ft.in

Source: Created by author.

Within all four cases, the mobility of the tanks employed had similar strengths. In all four cases, the ability to transit broken terrain, rubble, and push through buildings or road blocks proved invaluable to the attacking force. The 1st Marine battalion used the M48s to push through buildings making alternate routes for casualty evacuation. Similarly, in the Battle of Gaza City, the IDF also drove through buildings to create alternate routes. Both the IDF and the U.S. forces in Iraq used their tanks as battering rams, creating new entry points into buildings for infantry assaults. Each of these cases highlighted the mobility requirement of tanks operating in urban environments. In the amphibious assault, the USMC officers also lauded the mobility of the M1 Abrams, stating that once it was ashore, its mobility was superb. The ability to come ashore capable of conducting breaches greatly benefited the USMC officers and with excellent traction, is often utilized to tow other vehicles that become stuck. Each of these strengths greatly assisted their respective maneuvering forces. From these we can determine that a tank in the urban environment requires the ability to traverse rough terrain and debris, and the power to push through buildings and walls and tow other vehicles. The tracked nature of the tanks enables this maneuver.

Within each case, we also find similar weaknesses across the various tanks and battles. At nearly twelve feet wide, the first three cases encountered scenarios where the width of the tank prevented maneuver into critical areas. The U.S. Armor officers reported an average of one third of the city as off limits to tanks. The USMC in Hue also was unable to use the M48A3s in the northern portions of Hue due to size limits. The IDF became trapped by canalizing terrain in Lebanon that prevented maneuver out of enemy ambushes. In each of these cases the width of the tank became a limiting factor in its

ability to maneuver. With regard to amphibious operations, the width of the tank is primarily a consideration for the transportation of the tank. The size of the vehicle caused the tank to require more cube-space on the ship than other combat vehicles. In each case and type of operation, a smaller framed combat vehicle would outperform a larger one. This creates a requirement for a smaller tank than the ones in each case study.

The second weakness common to the cases was weight. The IDF fought in a desert city environment with limited to no sub-surface and did not experience issues with tank weights. The U.S. forces; however, did have issues with tank weights, mostly related to water crossings and causeways. In the Battle of Hue, the USMC was unable to support their initial attacks into Northern Hue because the bridge did not support the lighter weight of the M48A3. Similarly, in Iraq, the USMC and U.S Army had issues with bridge weights and canal causeways, allowing the enemy to shape the battlefield or preventing U.S. forces from utilizing certain avenues of approach.

With the USMC amphibious operations, the weight of the tank is a liability because the landing craft cannot support more than one tank. This greatly limits the ability of the landing force to deploy ashore in an organized and timely manner, violating the tenants of STOM. From these case studies we can determine that a requirement for a tank in urban and amphibious combat requires a lighter tank. The more weight the tank has, the more likely the tank will encounter weight constraints on mobility. See Table 2 for a comparison of case strengths and weaknesses for mobility.

Table 2. Mobility Comparison of Historical Cases		
Case	Strengths	Weaknesses
Hue	• Drove through buildings • Drove over rubble/ debris	• Width- inability to drive down streets in North Hue • Weight- couldn't use bridges
Israel	• Drove through buildings • Drove over rubble/ debris • Created holes in houses for Infantry	• Canalized into ambushes
Iraq	• Drove through roadblocks • Drove over rubble/ debris • Created holes in houses for Infantry	• Width- 33% of cities off limits • Maneuver damage to city • Weight-bridges and canal roads limit area tanks can go • Weight- damage to sewers/roads
Amphibious	• Traction on beach- able to tow • Configured to breach on landing • Towed other vehicles	• Size- cube space limit on ships • Weight- limit ship to shore delivery • Limited fuel supplies
Requirements	• Tracked- ability to drive over roadblocks/ debris • Power- ability to push track through houses/ walls, and tow • Breach Equipment mountable • Narrow enough to transit terrain • Light enough to utilize roadways/ bridges • Fuel capacity and burn rate for longer durations without resupply • Light enough increase number on landing craft, accelerate landing • Smaller space requirement on ARG vessels	

Source: Created by author.

Protection

The second aspect of analysis across the different cases is the protection provided by the tanks. In this regard, the cases differ; however, their performance with regard to protection by the tanks involved generally does not. Design considerations of the tanks utilized altered their success within each case. The M48A3 was built before RPGs became common and pre-exist the use of IEDs as the insurgent weapon of choice. The Merkava is designed for urban combat with the engine in the front and the crew in the hull to reduce their vulnerability. The M1 Abrams was designed for European battlefields

with armor heavily distributed to the front. In all four cases the protection provided by the tank was a strength. In the battle of Hue, the tanks absorbed high numbers of anti-tank strikes and continued to be operational.

The crews themselves fared worse with eighty percent of the crews becoming wounded. In the IDF campaigns, the tanks again absorbed numerous strikes from IEDs and RPGs, with a far greater percentage of the crew being uninjured. In Iraq, the M1 Abrams again absorbed numerous IED and RPG strikes, with Captain Glass being unable to distinguish between individual damage due to the numerous hits. In the USMC amphibious case, there were no reports of enemy contact to determine protection; however, the Marine officers believed based on their Iraq experiences that the protection was phenomenal. The first three cases proved the tanks were capable of surviving contact and continuing the fight. This demonstrates that the armor protection provided by the tanks is required for urban combat. As tanks were improved to increase crew survivability, protection continued to be paramount.

The weakness in the three of the four cases was also the same. The Merkavas that were destroyed in Lebanon were usually destroyed from underbelly IEDs. The M1s in Iraq also had issues with underbelly strikes and IEDs that targeted areas not covered as well by the armor. Following Lebanon, the IDF reinforced their underbelly armor because of the success Hezbollah had with the underbelly IEDs. The U.S. Armor officers interviewed all identified that the M1 Abrams has a weakness with top down, rear, and underbelly attacks. These weaknesses dictate a requirement for tanks to have all around protection to both the crew and the vehicle. This enables the tank and crews to continue fighting after numerous contacts and continue to support the infantry. The fourth case did

not identify any weaknesses due to the nature of training and lack of enemy contact. See Table 3 for a comparison of case strengths and weaknesses for protection.

Table 3. Protection Comparison of Historical Cases

Case	Strengths	Weaknesses
Hue	• Operational- tanks continued to operate after numerous RPGs	• Survivable- crews continually wounded/ killed
Israel	• Operational- tanks continued to operate after numerous RPGs • Survivable- crews generally survived contact	• Underbelly Armor- tanks destroyed by IEDs
Iraq	• Operational- tanks continued to operate after numerous RPGs • Survivable- crews generally survived contact	• Underbelly Armor- tanks destroyed by IEDs • Top Armor- crews killed by top down attacks, tanks disabled • Rear Armor- tanks vulnerable to attacks from rear/ flanks • Exposure- most crewmen killed were out of the hatch
Amphibious	• Untested	• Untested
Requirements	• Armored- tanks must be able to withstand numerous anti-tank weapon impacts and continue to operate/ crew survive • All Around Armor- tanks require equal protection on all surfaces • Exposure protection- crew require protection when operating out of the hatch or require the ability to operate from within the tank	

Source: Created by author.

Firepower

The final aspect for comparison between the case studies is the firepower provided by the tanks in the urban environments. All four cases utilized tanks that provided similar capabilities, although the M48A3 had some technological disadvantages due to the time period. All the tanks had a main gun designed for open battlefields. They each have a main gun in excess of 90mm, equipped with a 7.62mm variant coax machine

gun. All the tanks have a .50 caliber equivalent heavy machine gun mounted to the commander's station and a secondary 7.62mm machine gun. The M1 Abrams and Merkava have night vision capabilities that the M48A3 lacked. Within the four cases, the tanks share strengths and weaknesses with regard to firepower.

Table 4. Firepower Comparison of Historical Cases

Case	Strengths	Weaknesses
Hue	• Able to destroy enemy strongpoints • Able to create holes in buildings • Able to cover multiple AoA • Availability- on call at all times	• Night Sights- unable to target • Traverse- barrel to long to turn turret between buildings • Elevate/ Depress- unable to engage upper/lower level enemy
Israel	• Able to destroy enemy strongpoints • Able to create holes in buildings • Able to cover multiple AoA • Availability- on call at all times • Thermals identify snipers	• Deadspace- Crew unable to engage close in targets with tank • Traverse- barrel to long to turn turret between buildings • Elevate/ Depress- unable to engage upper/lower level enemy
Iraq	• Able to destroy enemy strongpoints • Able to create holes in buildings • Able to cover multiple AoA • Availability- on call at all times • Thermals identify snipers/caches	• Deadspace- Crew unable to engage close in targets with tank • Traverse- barrel to long to turn turret between buildings • Elevate/ Depress- unable to engage upper/lower level enemy
Amphibious	• Able to destroy enemy strongpoints • Most precise weapon system in USMC amphibious force • Able to cover multiple AoA • Availability- on call at all times	• Availability- unable to bring to shore with first waves/ unsecured beach
Requirements	• Main gun with explosive round able to create holes in buildings • Advanced optics with night and thermal sights • Short barrel able to traverse laterally on most roadways • Ability to super-elevate/ depress main gun • Multiple machine guns to cover separate avenues of approach	

Source: Created by author.

The strength of all three tanks in the urban environment was its ability to bring a significant amount of firepower to the fight. In all four cases, officers noted the ability of the respective tanks to identify and destroy enemy strong points. The USMC in Vietnam, the IDF in Lebanon and Gaza, and the U.S. forces in Iraq all used the main gun to destroy enemy strong points or to create holes in buildings. The IDF and U.S. Army in Iraq were able to use thermals to identify snipers and then engage with main gun or coax machine guns. USMC officer stated that the precision and target acquisition capabilities of the M1 Abrams far exceeds any other USMC platform. These strengths dictate a requirement for large caliber main guns armed with high explosive rounds capable of destroying strong points and creating large holes in walls. There is also a requirement for thermal sights for urban battlefields.

Each army also utilized the numerous machine guns on the tanks to cover crucial positions. The ability of the tanks to place machine guns in locations that infantry could not go, or to engage targets in multiple directions was invaluable in both Hue and Iraq. The other aspect of the tank each army lauded was its availability. In Hue, Iraq, and Gaza, weather or priorities would prevent air support from supporting ground maneuver elements; however, the tanks provided direct fire accurate and available large caliber munitions on call. These strengths demonstrate that a large caliber readily available main gun with advanced optics and multiple machine guns is a requirements for urban warfare.

The weaknesses of the platforms in each case study were also the same. All four forces had issues with elevation and depression of the main gun tubes. In Iraq, U.S. Army and USMC forces had to rely on carbines and rifles to cover close into the vehicles. When infantry was available, they would advance ahead of the tanks to root out enemy

anti-tank teams and only bring the tanks forward when enemy strong points needed to be engaged. These weaknesses dictate a requirement for a main gun able to super elevate and depress to engage enemy forces.

In each battle the ability of the tank to traverse its turret to the side was limited by the close proximity of buildings and terrain. This prevented the tanks from being able to engage lateral targets and added to their vulnerability. Crews would have to withdrawal back to be able to engage the close in or lateral targets. These weaknesses demonstrate that a tank in the urban environment requires the ability to traverse to the flanks in tight quarters. The longer the barrel extends beyond the hull, the more likely it is to be unable to engage lateral targets. With nearly all targets being in close proximity, long barrels, which are designed to improve accuracy on long distance fires, are not required. See Table 4 for a comparison of case strengths and weaknesses for firepower.

Summary

From the cross case analysis of the four individual cases, this research study identified strengths and weaknesses with regard to mobility, protection, and firepower of each tank involved. Those strengths and weaknesses for each attribute determined a set of requirements which a tank design required to operate in the historic environments of urban and amphibious warfare. Table 5 below summarizes the requirements from the historical cases.

Table 5. Tank design Requirements based on Historical Case Studies	
Mobility	• Tracked- ability to drive over roadblocks/ debris • Power- ability to push track through houses/ walls, and tow • Breach Equipment mountable • Narrow enough to transit terrain • Light enough to utilize roadways/ bridges • Fuel capacity and burn rate for longer durations without resupply • Light enough increase number on landing craft, accelerate landing • Smaller space requirement on ARG vessels
Protection	• Armored- tanks must be able to withstand numerous anti-tank weapon impacts and continue to operate/ crew survive • All Around Armor- tanks require equal protection on all surfaces • Exposure protection- crew require protection when operating out of the hatch or require the ability to operate from within the tank
Firepower	• Main gun with explosive round able to create holes in buildings • Advanced optics with night and thermal sights • Short barrel able to traverse laterally on most roadways • Ability to super-elevate/ depress main gun • Multiple machine guns to cover separate avenues of approach

Source: Created by author.

Future Operating Environment- Megacities

The final case study examines the future operating environment of megacities for both the USMC and the U.S. Army. This case study will examine the growth trend of cities, characteristics of megacities collectively, topographical issues, and how they will affect the mobility, protection, and firepower of an armored force operating within them. Understanding how megacities differ from the cities the case study forces have experience with will inform the design requirements for an armored platform operating within. The study will utilize open source data and scholarly articles to gain a better

understanding of the nature of the megacity urban environments, firstly as a general concept, and secondarily, with consideration to the particulars of current megacities.

Growth and Future OE

Both the USMC and the U.S. Army have identified the megacity as a likely future operating environments. According to the USMC manual, *Ship to Objective Maneuver,* "the migration of populations to the global littorals—congregating into mega-cities such as Shanghai, Jakarta, and Mumbai. Most ports and airfields are located near the epicenters of these dense masses of people . . . about 4 billion people will live in the littoral regions by 2050."[161] With the USMC's primary focus operating in the littoral regions, the growth of megacities in these regions dictate that understanding them is paramount for planning future operations, training, and equipping. Similarly, the U.S. Army Strategic Studies Group (SSG) and Unified Quest initiatives have identified megacities as probable future areas of operation. The Strategic Studies Group report stated that the number of megacities would grow from roughly twenty-three at the time of the report in 2014, to more than forty by 2035. These cities would account for sixty percent of the world's population and seventy percent of the world GDP by 2030.[162] Because these cities occupy strategic terrain or act as access control points for critical resources, these cities are likely to influence national objectives or serve as tension points for future conflicts.[163] Control of megacities will lead to the control of critical resources and economic power, which hostile actors will want to gain influence or control of.

Characteristics

While conducting research for the U.S. Army on megacities, the SSG developed six key characteristics that define the environment of each megacity. The first characteristics is context. Context is simply the acknowledgement that every city is unique and an in-depth understanding of what makes the city unique is required to operate in that city.[164] The laws, history, population make up, etc., all affect how a megacity functions and how it can be influenced. Understanding the formal and informal power dynamics within the city will be vital to any force attempting to operate within. Whether these dynamics favor the threat or friendly forces will directly impact a units ability to meet mission objectives.

Scale is the characteristic with regard to how large the city is and how much terrain it encompasses. The size of the city will deny a unit the ability to control the city and conduct many tactical tasks. There are not enough forces to in the entirety of the U.S. Army and its components to isolate or secure any megacity.

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Figure 9. Integrated Megacity

Source: National Geographic, "Megacities: AbuDhabi," last modified 2017, accessed 28 September 2017, https://natgeotv.com/me/megacities/galleries.

The third characteristic is density. Density is defined by how packed together the structures and people in the city are. The density of each will form physical and psychological barriers to freedom of maneuver[165].

Fourth is Connectedness. Mega-cities are linked to each other through communications and economic means and cannot be isolated from the world. The city of New York has its own State Department to handle foreign affairs.[166]

The fifth element is the concept of flow. The ability of goods and services, people, and resources to move in and out of the city is vital to its survival. Military operations that disrupt this flow will exacerbate civil aspects and resource capabilities. A

starving population will quickly overwhelm or strip the military logistics system.[167] The final characteristic is threats, which exist internal to megacities. The size of the cities allow criminal gangs and insurgent forces to hide and build their forces.[168] These forces may be neutral to a U.S. force operating in the city; however, operations in their territory or that affect their power could turn them hostile. Combined these characteristics shape the requirements of a military force operating within the megacity.

Topography

A key characteristic of each megacity is the topography of the city. Cities built on constrained spaces tend to build up. The city of New York is an example. The island of Manhattan constrained the growth of the city early on, making space a premium. This resulted in larger, taller buildings, and narrow road ways. Because most roads were built prior to cars, they were not designed for large traffic and buildings border small sidewalks and roads. High-rise buildings are normal, with apartment buildings having more than ten stories.[169] Other cities such as Beijing are not constrained by geography and expand outward. Rio-de-Janeiro is built on the lowland along the sea with mountain chains crossing throughout, creating distinct zones within the city.[170] These topographical differences shape each cities growth patterns and characteristics.

Integration relates to how structured the city developed. Highly integrated cities such as New York and Seoul, were built over time with centralized and formal power systems. Resources were allocated, buildings regulated, and growth was controlled with zoning. Loosely integrated cities are the opposite, with little control or the inability to resource the growing population. The city grows exponentially with no zoning and many

structures not meeting any building standards. Infrastructure is unable to keep up. Moderately integrated is the middle ground.[171]

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Figure 10. Rio De Janeiro- Loosely Integrated Development (Favelas)

Source: Brooke Saward, "Touring a Favela in Rio de Janeiro," World of Wonderlust, last modified 2017, accessed 28 September 2017, http://www.worldofwanderlust.com/touring-favela-rio-de-janeiro/.

How a city grew directly affects military operations. Highly integrated cities tend to be "vertically integrated cities with towering skylines, densely packed apartment neighborhoods, and underground subways."[172] These cities have more structural organization, sky scrapers, and a greater sub-surface terrain. On the opposite spectrum, loosely integrated cities become "feral cities . . . since they grow with neither planning,

nor resources. The resulting slums that form around the nucleus of an urban center often quickly become denied areas ruled by ethnic enclaves, gangs and criminal syndicates, which present a perilous labyrinth in both the tactical landscape and the human domain."[173] These cities are less structured and have less sub-terrain; however, they also have large tracks of densely populated but ungoverned and unstructured growth, complicating military planning.

The final piece of topography relates to the age of the city. Many older cities of the developing world are built upon ancient infrastructure with narrow disorganized roads. The age of the city, and the pace of its development, affect how large or numerous the old city districts are. Most megacities will have at least one old city district; however, in a constrained geography like Rio-de-Janeiro, they chose to destroy the old city and build newer buildings.[174] Older city centers will have limited sub structure but likely will have narrow and haphazardly built roadways based on ancient traffic patterns.

Having discussed the characteristics and topographical considerations that shape megacity growth, this study will now look at how mobility, protection, and firepower are affected by a megacity. The various topographical and characteristics have differing effects on each.

Mobility

Megacities present a complex set of mobility issues. The large scale of a megacity prevents a unit from isolating the city. Rather than treating a megacity as part of the terrain and isolating, as dictated in FM 3-06 *Urban Operations*, the megacity is the entirety of the terrain and likely exceeds in scale the area of operations.[175] A force operating in this terrain requires the ability to transit quickly through as they will be

under observation at all times. The connectivity will allow threat and neutral forces to pass information quickly and target a slow moving force. The different parts of the city will each have unique challenges units will have to contend with as they cross between.

The old historic districts are built with relatively short buildings ranging from two to four stories. Ancient city walls, narrow streets, and winding mismatched roads will make maneuvering of large combat vehicles nearly impossible. The new downtown districts are usually full of skyscrapers and high rise buildings. These urban canyons normally have several major roadways with many smaller crossing side streets and central squares.[176] These force armored vehicles to move along the major roads with limited mobility on the cross streets that are too narrow or heavily packed with cars and shops. The residential neighborhoods consist of a mix of high rise apartments similar to the downtown canyons or smaller tightly packed houses. Roads in these areas will also have a mix of wider main streets and narrow congested side streets and alleys. The mobility of large vehicles will be impacted for movement by both the size of the roads and the density of vehicular traffic, with much of the city off limits.

Most megacities experience massive road congestion. The Manhattan district in the city of New York is able to change population from 4 million to 1.4 million in a matter of hours because of the highly controlled and integrated nature of the city and its transportation control.[177] As the counterpoint, Dhaka's poor transportation system barely functions.[178] These problems of flow and density will shape both where and when armored forces can move.

In addition to the physical characteristics of the buildings and road networks are the limitations of roadways and bridges themselves. Bangkok has a large number of canal

systems running throughout the city, limiting mobility to bridges.[179] These bridges have limited weight bearing capacity depending on the construction and purpose of the bridge and expected traffic. Even in major U.S. cities, where integration and regulations are high, bridges and roadways limit the weight of vehicular traffic due to weight bearing capability limitations. The city of Seattle has a maximum weight capacity of 105,000 pounds (47.7 metric tons) for all bridges without special permit. Vehicles in excess of 105,000 pounds must travel in the center of the bridge one at time. Vehicles in excess of 150,000 pounds (68.2 metric tons) require the local government to conduct a survey to determine if the bridge can carry the weight.[180] Most cities are built along rivers and tributaries and all have sewage and canal systems to move water and waste. Cities with numerous bridge crossings will create weight barriers to armored forces attempting to move between different parts of the city.

These limitations are also true of the roadways themselves. Most megacities have expansive subway systems. Dubai has underground malls that connect various sky scrapers and run beneath the main roadways. Berlin has pedestrian walkways under key intersections. The road network above these various subsurface systems will have lower weight capacities than other roads, limiting armored vehicular movement or risking collapse into the sub-terrain.

Combined, these attributes of megacities generate requirements that a tank operating in these environments must be able to travel quickly, be small enough to maneuver into a greater percentage of the cities road networks, and be light enough that it doesn't collapse the roadway or bridges or limits the number of tanks that can traverse a bridge at the same time. The lighter and smaller a tank is, the easier it will be able to

maneuver the complex terrain of the urban megacity. However, tanks are not known for being light and small due to the requirements for protection.

Protection

The next aspect of armor that megacities will affect is its protection. With the large differences in vertical terrain that an armored vehicle will have to be in close proximity to, the top down threat to a tank is increased exponentially. Additionally, the numerous sub-terrain features, cross streets, adjoined buildings, tunnels, and uneven topography, will provide any enemy forces numerous opportunities to position at all angles of attack.[181] The term 360 degree battlefield fails to do justice to the three dimensional nature of the megacity. Armored forces require protection from 360 degrees on both the vertical and horizontal planes. The all-around protection necessitates requirements for adequate armor on every surface of the tank, increasing the weight.

When countering enemy anti-tank weapons, many militaries develop active defense measures into their tanks. The nature of megacity warfare will negate many aspects of these active defense systems. These systems require standoff to identify incoming rockets and launch counter projectiles. In an urban setting with narrow winding roads and a density of signs and obstructions, the active defense systems may not have the stand-off required, or its use will impact into buildings and structures. Collateral damage from these systems could adversely affect the entire operation with civilian casualties. Additionally, the "urban area's ubiquitous buildings, the smoke and smog degrading both vision and laser designation, and polished surfaces reflection of those beams"[182] will reduce the effectiveness of the active defense systems ability to locate incoming rockets.

With regards to protection, a tank operating in a megacity generates requirements for strong protection capabilities in all directions. It would also be limited in its ability to employ active defense measures that cause collateral damage or might be blocked by the close proximity of buildings, overpasses, signs, and other objects. Stronger and thicker armor on all sides of the tank would be preferred; however, this will necessarily contradict the mobility aspect of the tank. Tanks operating in the megacity would require stronger but lighter armor packages that provide all around survivability.

Firepower

Finally, firepower in a megacity is also greatly affected by the nature of the cities. Just as the glossy building surfaces will confuse active defense systems, it will also confuse main weapon system targeting. This will reduce the effectiveness of laser targeting, range finders, and optical sensors. These obscuration aspects of the megacity generate a requirement for secondary visual optics capable of utilizing each weapon system when advanced systems are inoperable.

Second, the density of close buildings will prevent a tank from fully traversing its turret if the gun tube extends too far out from the main body.[183] Being unable to bring the main weapon system to bear on the target will prevent any tank from performing its primary role in an urban environment, destroying enemy strong points in support of infantry maneuver. This is again a factor in the geography of the city. Tanks operating in a megacity would therefore have a requirement for a shorter barrel main gun system capable of traversing laterally in most situations.

Cities such as Rio-de-Janeiro and San Francisco, are built on mountains and steep hills, with winding roads and suspended highways, bridges, and streets built at different

levels.[184] Tanks historically have a very limited elevation and depression due to the size of the breech and length of recoil on the main gun inside the turret. This limits the ability of tanks to engage targets above three stories or below the street level without sufficient standoff. Combine offset street heights and roadways and the tank dead space is greatly increased in the megacity environment. These vertical engagement issues lead to the requirement that tanks in the megacity have the ability to super elevate and depress the main gun tube in order to engage and destroy threats on multiple levels in close proximity to the tank. The elevation and depression would also limit deadspace near the tank.

Furthermore, highly integrated cities with strict building codes have "some sophisticated structures incorporate physical safeguards— blast walls, blast-resistant windows and, perhaps, or low-lying stories of unoccupied floors to mitigate risk of targeted attacks—into their design."[185] When attempting to engage enemy strong points in larger structures, armored forces will require high explosive rounds to be able to penetrate the reinforced buildings they may encounter. This is also likely to be experienced in old city districts with ancient city walls built to withstand siege engines. The megacity generates a requirement for the tank main gun to be able to fire a high explosive round capable of destroying threat forces barricaded in reinforced building structures and capable of creating holes large enough for infantry to assault through.

Most engagements in urban conflict have been at less than 100 meters and in a megacity, this trend would continue. Most modern tanks are designed to fight at distance with long range sensors. Most urban settings do not provide standoff opportunities to engage targets beyond 400-600 meters in the best circumstances and a determined threat force would choose ground that eliminates these options. This makes long range weapons

systems moot in the urban fight; however, the tank will still have a requirement for advance optics with thermal and night capability to identify enemy forces operating in terrain that favors small unit maneuver. The weapon systems will also have a requirement for selective fire capabilities in order to limit collateral damage and target individual threats selectively in a populated area.

Lastly, the megacity with its density in population, is likely to have numerous civilian personnel in close quarters with any combat actions. The ability of the tank weapon systems to discriminate targets and reduce collateral damage and civilian casualties will be paramount in the megacity. With the large number of street gangs, and importance of information warfare in future megacity battles, civilian casualties will reduce the effectiveness of the unit or turn neutral forces hostile. The use of advanced optics with night and thermal sights and selective fire options will reduce likelihood of civilian casualties. The requirements generated by the future operating environments are captured below in table 6.

Table 6. Future Megacity Operating Environment Requirements		
	Characteristic	Requirement
Mobility	• Old City, city "canyons" • Traffic (Civilians) • Bridges, Canals, Sub-terrain, road bearing capabilities • Scale of city- observation	• Narrow enough frame to traverse city • Narrow enough- traffic • Light enough to sustain operations • Speed of vehicle sufficient
Protection	• Vertical terrain/ subsurface • Obstacles, smog, blinding buildings/ surfaces	• Armor against anti-tank weapons • All around armor • Little reliance on active defenses
Firepower	• Vertical terrain/ subsurface threat, tunnels • Old City, city "canyons" • Obstacles, Smog, blinding buildings/surfaces • Reinforced structures, ancient walls • Limited sight distances • Civilians	• Super Elevate/ Depress, multiple machine guns to cover several AoA • Short barrel to traverse • Secondary sights, improved laser targeting • Main gun round capable of destroying reinforced structures • Short range optics requirement • Target Discrimination, selective fire • Advanced sights with thermals to identify snipers/ threats

Source: Created by author.

Summary

The fifth case study examined the nature of megacities. This includes the characteristics and the topography of the megacity, and its effects on the mobility, protection, and firepower for a tank that operating in those conditions. Every megacity is unique in its size, density, connectivity, topography, and threat. Each presents unique challenges that must be considered; however, when examined as a category, several trends emerge. First, mobility within a megacity is impacted by the level of integration and the weight bearing characteristics of the city. The urban landscape will vary from dense, disorganized slums and old city districts to urban canyons created by hundreds of

high rise buildings with narrow cross streets. Combined with water way systems, overpasses and raised highways, and geography, and mobility of heavy armor is greatly impacted.

Second, protection in every direction is paramount as the ability of a threat force to maneuver on and engage a tank from multiple directions is enhanced by the addition of sub surface and super surface transit. Finally, the firepower requirements a megacity creates, limit the size and distance of engagements and necessitate a highly flexible weapon system able to engage targets discriminately in upper stories and subsurface engagements. Any tank designed for megacity combat would need to take these considerations into account when planning operations.

M1 in the Future Operating Environment

The final level of analysis will examine the fifth case study, the future operating environments, and compare its impacts on the requirements for tanks from the historical case studies, and then against the M1 Abrams MBT strengths and weaknesses. As cities grow larger and more complex, there is an increasing possibility of these changes will alter the requirements for tanks to operate effectively. This study will compare the operating environments in the historical case studies to the anticipated future operating environments case and determine if any characteristics in the future environments that will exacerbate, nullify, or add additional requirements for operating tanks within. This analysis will again examine the aspects of mobility, protection, and firepower and the future operating environment.

This analysis will also examine any shortcomings of the M1 Abrams and if they are magnified or nullified by the characteristics of the megacity and amphibious

operations. The analysis will determine if there is a change in characteristics between the historical case studies and the future operating case studies and then compare the strengths and weaknesses of the M1 Abrams identified in the Iraq and USMC amphibious operations case studies to the future operating environments requirements. Strengths and weaknesses in the requirements generated for the future operating environments, especially those exacerbated from the historical cases, will determine if the M1 Abrams maintains the ability to successfully operate in the future operating environments.

The USMC future operating environment identified two environments for their future operating environments, the littorals, and megacities in the littorals. Based on the unchanged nature of amphibious assaults when not conducted in megacities, this study will assume that the requirements identified in the fourth case study, USMC amphibious operations with the M1, will remain requirements in future amphibious operations. The requirements for a tank to operate in megacities in the littorals are the same as those not located there. Additionally, the USMC tank would likely be the same tank the U.S. Army used for megacities if the U.S. Army maintained the M1 Abrams, a new heavy tank built for open battlefields, or built a medium tank specific to the future operating environment. With these considerations, this study will focus on the megacity for the future operating environment case study, maintaining the requirements from the amphibious case study in the future operating environment, and compare the M1 Abrams to these requirements. Table 7 compares the capabilities of the M1 Abrams to the previous urban operations requirements and future urban operations requirements to indicate areas of strength and weakness for the M1 Abrams tank.

Table 7. Comparison of M1 to Previous and Future Operating Environment			
	Previous	Future	M1 Abrams
Mobility	• Tracked • Power to push through walls, tow • Breach Equipment @ • Narrow- roadways • Fuel- sustain on landing@ • Light enough- terrain • Light enough- landing@ • Smaller cube space requirement@	• Tracked • Power to push through walls, tow • Breach Equipment • Narrow*- roadways • Narrow* - traffic • Fuel- sustain on landing • Light enough*- terrain • Light enough- landing • Smaller cube space • Speed* of vehicle sufficient	S- Tracked S- Power **W- Width, buildings** **W- Width, traffic** **W- Weight, terrain** **W- Weight, landing** **W- Fuel requirements** W- Space requirement on ARG *S- Speed*
Protection	• Armored- Anti-tank • All Around Armor • Exposure protection	• Armored- Anti-tank • All around armor* • Little reliance on active defenses	S- Withstand anti-tank **W- Top, Rear, Under** W- Does not exist
Firepower	• Main gun with HE • Advanced optics with night and thermal sights • Short barrel • Super-elevate/ depress main gun • Multiple MG • Available on demand	• Main gun with HE • Advanced optics with night and thermal sights* • Short barrel* • Super Elevate/ Depress* • Multiple MG • Available on demand • Secondary sights, improved laser targeting • Short range optics requirement • Target Discrimination*	S- Main Gun with HE *S- Optics, thermals* **W- Unable to traverse** **W- Limited vertical capability** *S- Three separate MG* S- Integrated into maneuver forces S- Manual sights backup S- 3x sight **NA- only .50 Cal has single round capability**
Notes: W = Identified Weakness of M1, S = Identified Strength of M1 * denotes requirement that is significantly increased in megacity environment **Bold denotes M1 weakness corresponding with a significantly increase requirement** *Italics denotes M1 Strengths corresponding with a significantly increased requirement* @ Identifies Requirement from Amphibious Assault Case that remains for Future OE			

Source: Created by author.

Mobility

The first aspect of the tank this study will examine is the requirement for mobility of tanks in megacities compared to previous battles in urban environments. In the previous battles, the tank required the ability to traverse broken, rubbled terrain. The tank was also required to have enough power to punch through structures or obstacles. In the megacity case study there is no reason that these requirements would not continue to exist. As there are not examples of combat in megacities to contrast, the study must assume that the requirements for a tracked vehicle capable of pushing through obstacles, crossing over rubble, and being used as a battering ram will continues to exist. The M1 Abrams from the case study on Iraq, met these requirements.

There were two additional requirements for tanks in the megacity case study. The third requirement tanks succeeded at and identified in the historical case studies was the ability to incorporate breaching assets. The M1 Abrams has this capability and meets this design requirement. This requirement will remain in amphibious operations and is likely to be employed in megacity operations as well. Finally, although not identified as a requirement for the historical case studies, the megacity study identified a significant increase in the requirement for speed in order to traverse a battlefield quick enough while under observation to conduct operations. The M1 Abrams currently has a capability of reaching 42 MPH and meets this future requirement.

The first major requirement that was a weakness of the tanks identified in the cases was the width of the tanks. In all three cases of urban warfare, the width of the tanks prevented them from maneuvering into critical areas. The addition of traffic and congestion further complicated the ability of tanks to operate in these urban

environments. This generated a requirement that tanks needed to be smaller than the current 12 feet in width of the tanks in the case studies. The megacity case study demonstrates that this weakness is further exacerbated in a megacity. The increase in high rise buildings, narrow roadways, and slums will create larger areas of cities that tanks cannot traverse. With the M1 Abrams identified to wide to operate in the current environments, it will have more difficulty in the megacity environment.

The second requirement that was a weakness of tanks identified in the historic case studies was weight. In Hue, tanks could not cross bridges to reach the northern portion of the city. In Iraq, tanks were unable to use key roadways or bridges due to weight. In amphibious operations, the weight of the tank is detrimental to its deployability in landing craft. These combine to generate a requirement for a lighter tank in the current environment. In the future environment of the megacity, weight was identified as a significant issue. The inclusion of numerous small bridge and water crossings common to urban areas, the number of overpass and raised highways, and the addition of a substantial sub-terrain will increase weight restrictions when operating in the future operating environment. The M1 Abrams, although not the heaviest tank in the case studies, already has experienced issues with weight in Iraq. The current design would be problematic in a megacity, especially with a loosely integrated development.

Protection

The second aspect of the tank that this study examined is the requirements for protection of tanks in the various case studies. In the historical operating environments, all four case studies demonstrated the same strengths and weakness and the tanks involved. Because of the numerous anti-tank weapon systems being fielded and the

proliferation of IEDs, the ability of tanks to withstand contact is paramount to their success. The megacities case study also projects this requirement to continue. The ability of threat forces to attack tanks with IEDs and anti-tank weapon systems will only continue to increase. The M1 Abrams demonstrated a superb ability to withstand these attacks and continue to fight.

The primary requirement of tanks identified in the historical case studies that was also a weakness of the tanks was the all-around protection of the vehicle. Although the tanks were heavily survivable in the historical environments, the tanks that were destroyed were normally done with top down, rear, or underbelly attacks. The megacity case study demonstrates that this threat only increased in magnitude as the sub-terrain and super surface increase in scale. The M1 Abrams, which is heavily armored to the front, performed poorly in this aspect. The M1 Abrams is not well suited to all around protection in the megacity environment.

Firepower

The final aspect of tank operations in megacities this study will examine is firepower. In each case study, the requirements identified and a major strength of the tank was its ability to provide timely, large caliber fires with precision. In Iraq and Gaza, the ability to use thermal and advanced optics aided the armies in their attacks. The ability to provide large caliber direct fire enabled the armies to target and destroy enemy strong points. The ability to utilize multiple machine guns also enable these armies to overwhelm their enemies. The megacities case study projects the same requirements on a future battlefield, with the exception of issue related to laser targeting and range finding. The M1 Abrams excelled at these aspect of firepower while operating in Iraq and would

continue to provide this firepower in a megacity. Issues related to target discrimination and laser range finding are negated by the redundant manual sites the tank provides.

The biggest weakness of the tanks in the historical operating environment that was identified as a requirement was the ability to traverse the turret to the flanks and to elevate or depress the main weapon system. In Iraq, the U.S. forces were forced to use carbines in close in encounters or withdraw to a distance where they could engage targets on upper levels. The characteristic of the threat and the cities, made this problem relatively minor in the historical environment. The nature of the megacity will greatly exacerbate these issues. The megacity environment requires a tank capable of super elevating the turret, with a barrel short enough to conduct lateral engagements in close quarters. The M1 Abrams fails to meet these requirements. Although some mitigations can be emplaced with infantry operating in and around the flanks of the M1, the great increase in elevation changes near tanks will prevent the M1 Abrams from being able to engage a far greater number of targets, leaving the forces involved more vulnerable.

Summary

The study of historical case studies and the ability of the tanks involved identified a list of requirements for tanks to operate in those environments across the attributes of mobility, protection, and firepower. The study of the future operating environments also identified a series of requirements for tanks to successfully operate within those environments. When compared, this research study determined which requirements remain for the future operating environments and which ones were exacerbated or mitigated. Having completed the comparison of the historical to future cases, this

research study then compared the strengths and weaknesses of the M1 Abrams MBT across the attributes of mobility, protection, and firepower to those requirements.

Several aspects of the M1 Abrams MBT meet the requirements of the future operating environment of the littorals and megacities. The ability to withstand numerous engagements by anti-tank weapons and continue to fight, the ability to traverse broken terrain and push through obstacles and walls, breach, and identify and engage targets are favored by the M1 Abrams. However, the ability of the M1 Abrams to operate in weight restricted environments, drive into areas with narrow roadways, deploy from naval vessels, survive enemy attacks from all directions to include underbelly and top down, and the ability to engage targets at higher and lower elevations in close proximity greatly reduce the capability of the M1 Abrams to operate effectively in the megacity environment. The M1 Abrams could be successful in a megacity when used in portions of the city that do not have the overarching characteristics that limit their performance, such as air ports, rail yards, and residential neighborhoods that have low rise buildings.

Based on these findings, this research study can now answer the primary research question: Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the global littorals and Megacities? The short answer is yes. The future operating environments require a lighter weight tank capable of traversing the numerous weight restricted environments present in a megacity and capable of deploying on landing craft in greater numbers. This tank also requires a smaller frame, capable of maneuvering in the tight spaces of a megacity and the smaller size would greatly benefit the USMC in their ability to transport the tanks in their vessels. Finally, revamping the main gun systems to include the ability to traverse in tight

quarters, and to super elevate and depress to engage close in targets at a myriad of elevations would significantly improve the tank capabilities. Finally, the M1 Abrams armor package is designed in a manner that is detrimental to the survival of the crew and tank when engaged from most directions, which increases in likelihood in the megacity environment. Each of these capability gaps have existed but been mitigated in the historical cases by the environments; however, the megacity will exacerbate them.

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CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The fifth chapter of this research study will draw conclusions from the research completed and make recommendations from the results for the joint force. The fifth chaptered will discuss the conclusions of the study by explaining the methodology used to answer the research questions, give specific answers to the secondary research questions, and then answering the primary research question, "Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the global littorals and Megacities?" Following the conclusions, the study will make recommendations for the joint force derived from the answer to the primary research question and then to any future research that should be completed based on the findings or scope of this study.

Conclusions

This research study answered the primary research question using the qualitative analysis methodology of multiple case studies. The study used five case studies with a defined boundary in order to clearly articulate which references apply.

The first case study was the Battle of Hue. This battle highlighted the capabilities of a heavy tank operating in an urban environment against a determined and effective enemy force. This case study relied predominantly on historical texts and scholarly sources.

The second case study examined the Israeli experiences in the Second Lebanon War and Operation Cast Lead. This case study represented a recent offense by similarly

equipped heavy armored units into an urban environment against a determined enemy. This case study will also relied predominately on scholarly publications.

The third case study was Operation Iraqi Freedom (OIF). Although this operation encompassed ten years and half a dozen independent battles across different cities, the general characteristics of each city in Iraq were very similar and operations were conducted by similarly equipped U.S. Forces. The study examined several battles within OIF for commonalities across the battles. It utilized both scholarly publications and interviews with U.S. Army and USMC Armor officers and soldiers regarding their observations about the performance and limitations of the M1 Abrams during these battles.

The fourth case study for analysis was bounded by recent Amphibious Assault exercises by the USMC. These recent exercises highlighted the performance of the M1 Abrams as the primary tank of the USMC and its limitations. The study used both USMC after action reviews and interviews with USMC amphibious warfare experts experienced with the deployment of the M1 Abrams during amphibious assaults.

The final case study analyzed the future operating environment for both the USMC and the U.S. Army. This case study examined megacities and their likely impacts on maneuver forces, specifically tanks, operating within. This case examined the anticipated growth of megacities, the characteristics of megacities, and how the megacities will influence operations. This study evaluated the requirements that these impacts will generate for the force.

This research study then compared the individual cases to determine the requirements of a tank operating in the historical examples. These requirements were

analyzed against the requirements identified in the fifth case study on megacities and against the strengths and weaknesses of the M1 Abrams with regard to mobility, protection, and firepower. Based on this analysis, the research portion of this study answered the following secondary research questions:

What are the characteristics of the future battlefield environments that will impact the operation and employment of tanks in relation to maneuver, firepower, and protection?

This research study determined that there were several critical characteristics within the future battlefield environments that would impact the employment of tanks. The first set of characteristics with regard to the mobility of the tanks affect the size and weight of the tank. The inclusion of "old city" neighborhoods of megacities, urban canyons created by multi-story buildings, and numerous small cross streets and alleyways all limit the mobility of larger vehicles. The limitation of weight bearing characteristics of roadways, canals, bridges, and overpasses will reduce the ability of large armored vehicles to operate freely. In regards to protection, the interlaced surface, subsurface, and super-surface will create numerous avenues for threat forces to surround and engage tanks from all directions. This will increase the likelihood of tanks being engaged from all directions to include the top and underbelly. Finally, regarding firepower, those same elevation changes, old city walls, reinforced structures, and the materials creating blinding surfaces will all affect the ability of weapon systems to effectively engage targets and have affects. The inclusion of a dense civilian population will restrict freedom of fires and force tanks to contend with traffic and a threat force capable of blending into the population.

What are the maneuver, firepower, and protection capabilities required for a tank to operate effectively in these environments?

Table 8. Requirements for the Future Operating Environment		
	Future	
Mobility	• Tracked • Power to push through walls, tow • Breach Equipment • Narrow*- roadways •	• Narrow* - traffic • Fuel- sustain on landing • Light enough*- terrain Speed* of vehicle sufficient
Protection	• Armored- Anti-tank • All around armor*	• Little reliance on active defenses
Firepower	• Main gun with HE • Advanced optics with night and thermal sights* • Short barrel* • Super Elevate/ Depress* • Multiple MG	• Available on demand • Secondary sights, improved laser targeting • Short range optics requirement Target Discrimination*
* denotes requirement that is significantly increased in megacity environment		

Source: Created by author.

A tank operating in the future operating environments of the littorals and megacities will have several requirements related to mobility, protection, and firepower. Mobility requirements include having a tracked vehicle able to traverse rubble and debris, with sufficient power to push through walls and tow. The tank needs to be sufficiently narrow and light enough to traffic a sufficient portion of the city. The tank must maintain the ability to breach obstacles, and maintain enough speed to aid in assaulting objectives. The protection of the vehicle requires an all-around armor package able to withstand numerous engagements from anti-tank weapon systems and IEDs. The firepower requirements include a main gun capable of super elevation and depression, with a round

able to penetrate reinforced structures and create holes large enough for infantry to attack through. The barrel must be short enough to enable lateral traversing to engage targets. Multiple machine guns able to focus on more than one avenue of approach and advanced optical systems with thermal and night vision capabilities remain requirements.

Has the main battle tank operated in similar operating environments in the past and how have they performed in regards to maneuver, firepower, and protection?

The first four case studies identified examples of urban and amphibious environments where main battle tanks have operated in similar environments. These environments shared many of the characteristics of the future operating environments. The scale and density challenges did not exist and mitigated several of the weaknesses.

Regarding mobility, tanks in the previous operating environments demonstrated strengths in the ability to traverse rubble and debris, push through buildings, and operate along major thoroughfares. However, these tanks each had limitations with regard to size and weight, unable to cross bridges and canal causeways, or to traverse many of the smaller roadways. The USMC amphibious operations were also limited in the ability to transport tanks to the shore in a rapid and timely manner because of the weight of the tank and the capacity of the landing craft.

The protection aspects of the tanks proved far better overall, with tanks surviving numerous engagements from IEDs and RPGS. The weakness of all around armor was identified in each case and had been exploited. With regard to firepower, the ability of each tank to traverse the turret laterally and to elevate or depress the main gun was identified as a weakness. Otherwise, the tanks provided a powerful, available main gun

capable of creating large holes in walls, engaging strong points, and identifying enemy personnel and caches.

Are there significant capabilities gaps with the main battle tanks in regards to maneuver, firepower, and protection when operating in these environments?

Yes, the main battle tanks and specifically, the M1 Abrams demonstrated significant capabilities gaps compared to the future operating environment (see Table 7). Each of the main battle tanks demonstrated weaknesses in mobility regarding the width and weight of the respective tanks. The ability to land combat formations from ARG vessels, traverse narrow roadways, or cross bridges, causeways, and road surfaces significantly impact the mobility of the main battle tank in the future operating environments. The main battle tanks and M1 Abrams also demonstrated a protection capability gap regarding all around armor and the ability to survive multiple anti-tank weapon engagements from all angles. Finally, there were firepower capability gaps in the ability to traverse the turret in narrow roadways, or to elevate and depress the gun tube sufficiently to engage targets in the relatively flat urban environments of the historical case studies. This gap only grows significantly more in the future megacity environment.

Based on the answers to the above questions, the study can answer the Primary Research Question: Do the U.S. Army and USMC require a medium tank to operate in the anticipated future operating environments of the global littorals and Megacities?

Having reviewed the requirements of an armored vehicle serving in the tank role in the future battlefield of megacities, the M1 Abrams is not suited to the mission requirements. The M1 Abrams has proven itself a capable tank when operating in large cities with relatively flat terrain and little to no sub-terrain. The cities of Iraq also have

relatively wide roads and open spaces with few tall buildings. Even in these environments, the weakness of the tank became apparent for element when conducting high intensity operations in Sadr City, Fallujah, Ramadi, and Najaf. Officers interviewed for this study identified several critical weaknesses that a more determined enemy could have exploited. This weaknesses are the exact same weaknesses that the megacity environment would exacerbate. Because the M1 is not well suited to the task, if the SSG firmly believes that the future operating environment will include megacities, a new tank developed for that environment should be built.

Recommendations

The primary recommendation of this research study is that the U.S. Army develop a medium tank that meets the design requirements of the future operating environment. The tank should make use of new technology to increase the protection while reducing the weight of the tank to be able to traverse a sufficient portion of megacity roadways and bridges. The exact weight requirements would need further study of potential future megacity battlefields. Although there is all around threat, a majority of threat attacks still originate from the frontal arc, especially when the tank is moving forward to engage enemy strongpoints. The Merkava demonstrated increased crew survivability with the crew located in the hull behind the engine. This design method should be considered. Regardless, the armor should be modified for even distribution from top, bottom, rear, and frontal protection of the tank.

The main gun should be capable of super elevation and depression. This could be accomplished by removing the turret and suspending the weapon system above the hull with an autoloader located in the hull. The main gun should be short barreled to

maximize lateral movements. In order to facilitate operations in non-urban terrain, an interchangeable long barrel could be included. The tank requires coaxial mounted machine gun as well as a large caliber machine gun that can be accessed by the commander on the top of the tank.

The tank requires tracks but should be sufficiently narrow enough to traverse a sufficient portion of future megacity environments. The exact width and portion of a city requirements the tank should be capable of traversing requires further analysis of possible future megacity operational environments. The tank must maintain sufficient speed to enable rapid maneuver and reduce enemy targeting of the tank with anti-tank weapon systems. Again, the exact requirement should be determined after future analysis of potential megacity environments. Ideally an engine with a fuel economy similar to the M2 Bradley would greatly benefit the ability of both the U.S. Army and USMC to sustain operations and reduce refuel requirements.

The requirement for open field battle and long distance armored combat by the U.S. Army will not be alleviated by the increase in megacities. Based on the current employment of forces in predominantly Middle Eastern countries, Europe, and Korea, the U.S. Army should designate one division as a medium urban division, fielded with the new medium tank. This division could test and develop megacity doctrine with platforms designed specifically for the urban megacity fight. Should the expectation for future operations expand in the number of megacity operations, further divisions could be converted. However, the U.S. Army needs to retain the M1 Abrams MBT or a similar heavy tank for large scale combat outside of cities.

The secondary recommendation of this thesis is the adoption of the new medium tank by the joint force, specifically, the USMC. The USMC would benefit from the lighter smaller tank platform in the conduct of amphibious operations. With an interchangeable barrel, the USMC version of the tank would be capable of fighting in open terrain where targets may exceed the short distances of urban terrain. These smaller tanks would also increase the landing craft capabilities to land tanks in pairs or platoons, increasing the ability land combat formations and rapidly deploy forces from the ship to the objective. The greater fuel efficiency would enable the landing force to sustain operations for a longer period of time before resupplying. The issue of the medium tank to the USMC would lower the per cost unit of each tank, improving development cost.

In addition to the USMC, the airborne and light brigades of the U.S. Army would benefit from having a medium tank to support operations. As noted in the literature review, following the removal of the M551 Sheridan from the light brigades and the cancellation of the AGS, the light brigades were left without a mobile protected firepower to augment the formations. The U.S. Army is already working to develop a mobile, protected firepower platform for this role in the airborne brigades. The medium tank could be fielded to these brigades instead, further improving the development cost and per unit cost of the medium tank and reducing the number of systems required to be maintained by the U.S. Army.

This research study has sought to answer the question, does the joint force require a medium tank in order to operate effectively in the future operating environments of the littorals and global megacities? Based on the research conducted, the study concludes that

the U.S. has a capability gap at the medium tank and urban megacity levels and should pursue development of a medium tank.

This research study has also identified several areas of potential additional research in order to further refine the requirements or capabilities of a medium tank in the joint force. First, research into considerations for tank development could include robotics and artificial intelligence. Modern and developing technology lends to the possibility that tanks could be outfitted with drone wingmen. Additional aerial drones could be incorporated into the computing system, providing three dimensional coverage of the tank and battlefield. These potential enhancements could help reduce weaknesses of the tanks and other weapon systems.

Second, research and an in depth analysis of potential future megacity battlefield would help determine the exact requirements required for a medium tank. The weight, size, and speed requirements identified as in this study are undefined. Analysis of bridge and roadway weight capabilities, roadway widths, and tunnel sizes, will guide development of specific requirements for tank development.

In conclusion, this research study has determined that the U.S. Army and USMC require a medium tank to support operations in the future operating environment. Additionally, the joint force would benefit from the adoption of a medium tank to augment the USMC and U.S. Army airborne and light infantry brigades. The exact specifications of this tank require further research into possible future megacity operating environments. Additional research into emerging technologies would also benefit future tank design and could offset future operating environment limitations.

APPENDIX A

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Consent to Participate in a Research Study

This study is a research project being conducted as part of a Master's program thesis. This study is being supported by the US Army for conducting the research.

Purpose of the Research Study

The purpose of the research being conducted in this study is to determine if the M1 Abrams Main Battle Tank (MBT) is an effective platform that will be suitable for conducting operations in the future. The Army Chief of Staff's Future Study Plan has determined that Megacities, cities with more than 10 million people, will play a significant role in future combat operations. The M1 Abrams MBT has been heavily used for urban operations in Iraq; however, the natural and manmade geography of those cities differs greatly from megacities. With the larger emphasis on urban operations, this study will examine if the M1 Abrams MBT platform will be adequate to operate in those environments or if the U.S. Army should invest in a new "medium" tank built for urban environments.

Procedures

1. *As a Participant in this study, you can expect to provide a single interview lasting approximately 30-60 minutes. After completion of the interview, you will be provided the transcript for confirmation of its accuracy. After reviewing the transcript, your participation in the study will be complete.*
2. *After initial contact, if you wish to provide your observations, please complete and return the consent form prior to the interview. The consent forms will be filed with the Quality Assurance Office (QAO) located at the Command and General Staff College (CGSC), Fort Leavenworth, Kansas for 3 years.*
3. *The participant, will schedule a time to conduct the interview either by telephone or in person.*
4. *During the interview, you will be asked questions using a semi-structured interview process related to your experiences utilizing the M1 Abrams MBT Platform.*
5. *Upon completion of the interview, you will be provided a transcript of the interview for review. You will be able to edit the transcript for accuracy or remove responses you no longer want recorded*
6. *The researcher will compile the answers from the interviews and remove any Personal Identifying Information (PII) from the completed work. The interview data will be maintained for 3 years by the researcher in a locked box*

Risks

Because you, the participant, are a Armor mid-level officers in the U.S. Army or USMC discussing the performance of the M1 Abrams MBT platform, there is a risk that your comments could anger superior officers within the branch, effecting your career. These risk will be minimized by separating all PII from the answers you provide in both the research and the consent forms in order to prevent any comments from being attributed directly to you.

Benefits

This is a research study and there is no expectation that you will receive any direct benefit from participation.

Confidentiality

Provide the following:

1. *Records from this research study will be maintained for three years in accordance with DODI 3612.02. The consent forms will be stored at the CGSC QAO office, fort Leavenworth, Kansas. Transcripts and demographic data will not have any PII and will be stored by MAJ Jeremy Zollin in a locked box at a separate location. This research study is conducted in compliance with the Human Subjects Protection Office standards and they or a DoD designee may inspect the records.*
2. *"All data obtained about you, as an individual, will be considered privileged and held in confidence; you will not be identified in any presentation of the results. Complete confidentiality cannot be promised to you, particularly as a military personnel, because information bearing on your health may be required to be reported to appropriate agencies.*

Contacts for Additional Assistance

1. *The only researched in this study is MAJ Jeremy Zollin. Should you have any questions or concerns about the study, please contact the investigator, MAJ Jeremy Zollin @ Jeremy.m.zollin.mil@mail.mil, Researcher.*
2. *Should you have any concerns about the conduct or context of the interview please contact Dr. Maria Clark @ marica.l.clark.civ@mail.mil, CAC LDE Human Protections Administrator.*

Voluntary Participation

Participation in a research study is voluntary. As a requested participant in the study you may say no to participation. You may also decline to answer any question, retract any answers in the interview, or to stop the interview at any point in time. You do not need to give a reason. Should you chose to retract your responses, they will be destroyed and all information you have provided will be treated as privileged information. No one can discriminate against you or treat you differently if you choose not to be in a research study or later decide to stop your participation.

Statement of Consent

I have read this form and its contents were explained. I agree to be in this research study for the purposes listed above. All of my questions were answered to my satisfaction. I will receive a signed and dated copy of this form for my records.

_____ ____/____/____

Signature of Research Subject Date

_____

Printed Name of Research Subject

_____ ____/____/____

Principal Investigator Signature Date

APPENDIX B

ARMOR OFFICER INTERVIEW QUESTION GUIDE

Interview Pre-Brief (Urban)

Thank you for participating in this study, relating your combat experience to the effectiveness of the M1 Abrams MBT in an urban environment. Your participation in this study is completely voluntary and you can decline to answer any question. You can also withdraw from the study at any time. You completed an informed consent form before we began; do you have any questions about your participation in this study?

This interview will be audio recorded and I will be taking notes during the interview. Feel free to ask questions or to return to previous questions at any time. Your input is extremely valuable, so please be detailed with your answers. You can stop the interview at any time. I will transcribe the interview and you will be provided an opportunity to review it. Because we will be discussing operations of the M1 Abrams and your combat experience, avoid discussing classified information or discussing any potential violations of the Uniformed Code of Military Justice when answering. Do you understand these instructions? Do you have any questions before we begin?

The purpose of this portion of the study is to examine the effectiveness of the M1 Abrams in urban environments. When you used the M1 Abrams in an urban environment, what was your position? Rank? What timeframe and city?

1. Please briefly tell me about one instance of when you used the M1 Abrams in an urban environment.

2. In respect to the mobility, what were the strengths of the M1 in the urban environment? Weaknesses?

3. With regard to the maintenance and logistical requirements for the employment of the M1 in the urban environment, what are the considerations/ limiting factors of the M1? (rules of thumb for timeline, task org)

4. In respect to the firepower, what were the strengths of the M1 in the urban environment? Weaknesses?

5. With respect to the protection provided, what were the strengths of the M1 in the urban environment? Weaknesses?

6. How would the M1 strengths and weaknesses be effected if:
    a. The buildings were 5-6 stories, 10 or more stories tall?
    b. The streets/alleys were narrower or buildings closer together?
    c. The bridge or substructures weight limits were lower?

7. Is there anything else about the M1 in an urban environment you want to discuss?

8. Do you know anyone else whose experiences should be included in this study?

APPENDIX C

MARINE OFFICER INTERVIEW QUESTION GUIDE

Interview Pre-Brief (Amphibious)

Thank you for participating in this study, relating your combat experience to the effectiveness of the M1 Abrams MBT in an amphibious environment. Your participation in this study is completely voluntary and you can decline to answer any question. You can also withdraw from the study at any time. You completed an informed consent form before we began; do you have any questions about your participation in this study?

This interview will be audio recorded and I will be taking notes during the interview. Feel free to ask questions or to return to previous questions at any time. Your input is extremely valuable, so please be detailed with your answers. You can stop the interview at any time. I will transcribe the interview and you will be provided an opportunity to review it. Because we will be discussing operations of the M1 Abrams and your experience, avoid discussing classified information or discussing any potential violations of the Uniformed Code of Military Justice when answering. Do you understand these instructions? Do you have any questions before we begin?

The purpose of this portion of the study is to examine the effectiveness of the M1 Abrams in amphibious environments. When you used the M1 Abrams in an amphibious environment, what was your position? Rank? What timeframe and location?

1. Please briefly tell me about one instance of when you used the M1 Abrams in an amphibious environment.

2. In respect to the mobility, what were the strengths of the M1 in the amphibious environment? Weaknesses?

3. With regard to the transportation requirements and deployment of the M1 from ship to shore, what are the considerations/ limiting factors of the M1?
   (methods, rules of thumb for timeline, task org, weather considerations)

4. What are the significant considerations of amphibious operations utilizing the M1 with regard to logistics and maintenance

5. In respect to the firepower, what were the strengths of the M1 in the amphibious environment? Weaknesses?

6. With respect to the protection provided, what were the strengths of the M1 in the amphibious environment? Weaknesses?

7. Is there anything else about the M1 in an amphibious environment you want to discuss?

8. Do you know anyone else whose experiences should be included in this study?

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