

DTIC FILE COPY

2

AD-A197 691

LESSONS LEARNED FROM 20TH CENTURY TANK WARFARE: DOES  
A COMMON THREAD OF LESSONS EXIST?

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

MASTER OF MILITARY ART AND SCIENCE

by

MATHEW L. SMITH, MAJ, USA  
B.S., United States Military Academy, 1976

Fort Leavenworth, Kansas  
1988

Approved for public release; distribution is unlimited.

88-3193

DTIC  
ELECTE  
SEP 02 1988  
S H D

88 9 2 022

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				
1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION U. S. Army Command and General Staff College		6b. OFFICE SYMBOL (If applicable) ATZL-SWO-GD	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State, and ZIP Code) ATTN: ATZL-SWO-GD Fort Leavenworth, Kansas 66027-6900		7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS		
		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
				WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) Lessons Learned from 20th Century Tank Warfare: Does a Common Thread of Lessons Exist?				
12. PERSONAL AUTHOR(S) MAJ Matthew L. Smith				
13a. TYPE OF REPORT Masters Thesis		13b. TIME COVERED FROM 8-1987 TO 6-1988	14. DATE OF REPORT (Year, Month, Day) 1988 June 3	15. PAGE COUNT 112
16. SUPPLEMENTARY NOTATION				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Lessons Learned, Tank Warfighting.	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This study is a historical analysis of lessons learned from major tank warfighting experiences of the 20th century concerning individual tank and small tank unit (company size or smaller) mobility, firepower, protection, command and control, and overall design. The aim of this study was to make a determination about the existence or nonexistence of a common thread of lessons learned during individual tank and small tank unit fighting. The major tank warfighting experiences examined were World War I, World War II, and the Arab-Israel 1967 and 1973 Wars. The lessons learned were gleaned from sources written by soldiers, engineers, and historians who had either participated in or studied the particular tank warfighting experience. Lessons learned are grouped into five areas: mobility, firepower, protection, command and control, and overall design.  This study concludes that a common thread of lessons learned concerning individual tank and small unit mobility, firepower, protection, command and control, and overall design does exist throughout the major tank warfighting experiences of the 20th century.				
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL			22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.  
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

Unclassified

LESSONS LEARNED FROM 20TH CENTURY TANK WARFARE: DOES  
A COMMON THREAD OF LESSONS EXIST?

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

MASTER OF MILITARY ART AND SCIENCE

by

MATTHEW L. SMITH, MAJ, USA  
B.S., United States Military Academy, 1976

Fort Leavenworth, Kansas  
1988

Approved for public release; distribution is unlimited.

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of candidate Major Matthew L. Smith

Title of thesis Lessons Learned From 20th Century  
Warfare - Does a Common Thread of Lessons Learned Exist?

Approved by:

John A. Reichley, Thesis Committee Chairman  
John A. Reichley, M.B.A., M.S.J.

Major Siro Cappellotti, Member, Graduate Faculty  
Major Siro Cappellotti, M.A.

Col. Don Martin, Jr., Member, Consulting Faculty  
Colonel Don Martin, Jr., M.A.

Accepted this 3rd day of June 1988 by:

Philip J. Brookes, Director, Graduate Degree Programs  
Philip J. Brookes, Ph.D.

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 government agency. (References to this study should include the foregoing statement.)

ABSTRACT

LESSONS LEARNED FROM 20TH CENTURY TANK WARFARE - DOES A COMMON  
THREAD OF LESSONS EXISTS: A historical analysis of the lessons  
learned concerning the major tank warfighting experiences of  
the 20th Century by Major Matthew L. Smith, USA, 112 pages.

✓ this  
This study is an historical analysis of lessons learned concerning  
tank mobility, firepower, protection, command and control, and  
overall design during the major tank warfighting experience of the  
20th Century. The aim of this study was to make a determination  
concerning the existence or non-existence of a common thread of  
lessons learned during individual and small unit (company size or  
smaller) tank fighting. The major tank warfare experiences  
examined were World War I, World War II, and the Arab-Israeli 1967  
and 1973 Wars. The lessons learned were gleaned from sources  
written by soldiers, engineers, and historians who had either  
participated in or studied the particular tank warfare experience.  
Lessons are grouped into five areas; mobility, firepower,  
protection, command and control, and overall design.

This study concludes that a common thread of lessons learned  
concerning individual and small unit tank fighting does exist  
throughout the major tank warfighting experiences of the 20th  
century. (✓) +



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution	
Availability	
Availability	
Dist	Special
A-1	

## TABLE OF CONTENTS

Chapter 1. Defining the Problem	1
Introduction	1
Historical Background	2
Research Questions	3
Significance of the Study	4
Methodology	4
Chapter 2. Survey of Literature	7
Part I - World War I	9
Part II - World War II	14
Part III - Arab-Israeli 1967-1973 Wars	17
Chapter 3. Lessons Learned from Past Tank Warfare	21
Part I - World War I	22
Part II - World War II	38
Part III - Arab-Israeli 1967-1973 Wars	55
Chapter 4. Analysis and Discussion	86
Mobility	87
Firepower	89
Protection	91
Command and Control	94
Overall Design	98
Chapter 5. Conclusions and Recommendations	101
Bibliography	105

## CHAPTER 1

### DEFINING THE PROBLEM

#### INTRODUCTION

The purpose of this study is twofold: to research the major tank warfighting experiences during the 20th century with the aim of identifying lessons learned concerning individual tank and small tank unit (company size or less) warfighting, and to analyze the identified lessons learned with the aim of determining whether or not a common thread of lessons exists.

The United States has designed its tank and tank forces to dominate a battlefield through superior tactical mobility, firepower, protection, and command and control. The United States has observed and participated in tank warfare throughout the 20th century and has documented shortcomings or deficiencies concerning mobility, firepower, protection, command and control and overall design in the participating tanks and tank forces. These shortcomings and deficiencies, or "lessons learned," will be the focus of this study. After a thorough examination and comparison, a determination regarding the possible existence of a common thread of lessons will be made.

## HISTORICAL BACKGROUND

Tank warfare was initiated during the later part of World War I. Tank forces were developed to break years of battlefield stalemate by defeating the effects of the machine gun, and restoring tactical mobility and decisive maneuver to the battlefield. While the tanks' significance during World War I is debatable, tanks would rapidly evolve into the centerpieces of every major 20th century land army.

Most tank battles that occurred in World War I, World War II, and the Arab-Israeli 1967-1973 Wars have been studied and lessons learned concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design have been identified and documented. Sources for these documented lessons learned are numerous and have been prepared by persons of diverse backgrounds, including soldiers, engineers, and historians. No single source, identified in this research, focused solely on lessons learned nor attempted in its scope to compare or link lessons learned from more than two of the major tank warfighting experiences of the 20th century. While it can be argued that some lessons learned are situational and are not always relevant to later combat situations, an examination and comparison of the lessons still needs to be conducted to determine whether a common thread of lessons learned exists.

## RESEARCH QUESTIONS

This study focused on two research questions:

- (1) What are the lessons learned from 20th century tank warfighting concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design?
- (2) Does a common thread of lessons learned exist?

## SIGNIFICANCE OF THE STUDY

The United States spends billions of dollars to develop and field a dominant tank, and dominant tank forces, for its ground maneuver forces. Tank forces are the centerpiece of US ground maneuver forces and their success or failure may well be the deciding factor in future high-intensity conflicts. If a common thread of lessons learned does exist, it can be used to establish a base line for current and future tank development and also can be used as part of the foundation for the development of tactics and tactical manuals concerning tank force organization and employment.

## METHODOLOGY

Historical research will be conducted to identify the lessons learned concerning 20th century tank warfighting. The historical research will include books and periodicals written by soldiers, historians, and subject matter experts who have either participated in or studied 20th century tank warfighting. After identifying the lessons learned, an analysis of the lessons will be conducted to determine whether a common thread of lessons exist. This study will be limited to lessons learned concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design. The thesis will be structured as follows.

### CHAPTER 1-- DEFINING THE PROBLEM

This chapter includes the introduction, the research questions, the significance, and the methodology for the study.

### CHAPTER 2-- SURVEY OF LITERATURE

This chapter provides the reader a quick look at all relevant sources of information used in this study. A short paragraph will detail what each source contains and will compare it with other sources.

### CHAPTER 3-- LESSONS LEARNED FROM PAST TANK WARFIGHTING

This chapter provides the reader a listing of lessons learned concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design from World War I through the Arab-Israeli 1967 and 1973 Wars.

### CHAPTER 4-- ANALYSIS AND DISCUSSION

This chapter provides the reader an analysis of the lessons listed in chapter 3 and makes a determination regarding the existence of a common thread of lessons learned.

### CHAPTER 5-- CONCLUSIONS AND RECOMMENDATIONS

This chapter answers the research questions and draws a conclusion of the meaning of the study. It also relates the study to other works and to the base of knowledge. Suggestions for future research are also included.

## CHAPTER SUMMARY

The purpose, background, and significance of this thesis have been established in this chapter. Additionally, the research questions and the study's methodology are included to provide the reader with the study's direction and content. In the next chapter the reader will be exposed to the sources of knowledge used to identify the lessons learned from 20th century tank warfighting.

## CHAPTER 2

### REVIEW OF LITERATURE

A review of literature is presented to familiarize the reader with the sources of knowledge studied and incorporated in this thesis. The review will also provide succeeding researchers a synopsis of information available relating to tank warfighting, design, and lessons learned.

The review of literature for this thesis consists of books and periodicals concerning tank warfighting, evolution, design, and capabilities. The sources range from those written during World War I to the present. The Combined Arms Research Library at the United States Army Command and General Staff College, Fort Leavenworth, Kansas, provided the foundation for documenting the thesis. The research material used in this thesis is unclassified.

The review of literature applicable to this thesis is divided into three sections. Part I examines literature concerning lessons learned from World War I. Part II examines sources of information concerning lessons learned from World War II. Part III examines literature concerning lessons learned from the Arab-Israeli 1967 and 1973 conflicts. Other literature was

consulted and is included in the bibliography. The following sources were the most beneficial.

## PART I - WORLD WAR I

### BOOKS

LTC Kenneth A. Steadman's work, The Evolution of the Tank in the U.S. Army, examines the evolution of the US main battle tanks from 1919-1940. Steadman examines the evolution of US tank design, military force organization, and mechanized doctrine, from the beginning of World War I to the start of World War II. He also provides an excellent discussion of the political issues and other factors that influenced US tank evolution.

In Tank Warfare: A History of Tanks in Battle, written by Kenneth John Macksey, the history of the policymakers and strategists is examined as it relates to the technical and tactical development of tanks. The work examines the development of armor and the key factors in the tank development process beginning with World War I and ending with the Vietnam War.

R.M. Ogorkiewicz's work, Design and Development of Fighting Vehicles, provides a detailed account of the progressive evolution of armored fighting vehicles and deals in depth with the many different aspects of armor design, including guns, missiles, engines, steering, and armor protection. Ogorkiewicz discusses

both military and engineering issues and features incorporated into the design of main battle tanks.

Armour in Conflict: The Design and Tactics of Armoured Fighting Vehicles, written by Ian V. Hogg, provides a graphic description of the international development of tanks in the context of evolving tactical systems. Hogg examines the interplay of engineers and soldiers in tank development and identifies many lessons learned from past armor conflicts.

Ralph E. Jones, George H. Rarey, and Robert J. Ickes provide a very detailed source with their book, The Fighting Tanks Since 1916. This work provides an excellent history of tank warfare during World War I including technical discussions of tank design, employment, and anti-tank defenses and foes. The authors provide many World War I lessons learned.

An excellent source for World War I and World War II lessons learned is Our Armoured Forces written by Gifford Le Quesne Martel. This work examines tank warfare involving US, German, British, French, and Soviet forces. It focuses on tank warfare in North Africa, Italy, the Soviet Union, and France and lists many lessons learned from specific battles.

R.M. Ogorkiewicz's Armoured Forces analyzes the development of tank design in several countries, including the US, Soviet Union, Britain, Japan, France, and Italy from the beginning of the

20th century to the end of World War II. This source contains many lessons learned and explains how tanks were modified to incorporate them.

The Evolution of Weapons and Warfare, written by Trevor N. Depuy, provides a detailed examination of tank warfare in World War I and provides many lessons learned. Depuy provides many battlefield facts and statistics about the employment and engagements between tank forces. This source contains a good discussion of the Battle of Cambrai.

Sir Ernest N. Swinton's Eyewitness, provides a collection of personal reminiscences of certain phases of World War I. Swinton provides information about what he observed, heard, and knew about World War I tank fighting and development. The work focuses on the devastating effects of the employment of the machine gun and how the British developed their tank force to counter it.

An excellent source for US tank development and warfighting lessons learned is The Patton Papers 1885-1940, by Martin Blumenson. This source contains Patton's written correspondence about World War I tank development and fighting and has many facts and lessons about how the US Tank Corps was established and how it fought.

Paul Albert Dyster's work, In the Wake of the Tank, conducts an excellent study of the birth and evolution of armored warfare doctrine and technology throughout the 20th century. Dyster takes a detailed look at World War I, the interwar period, World War II, the early atomic age, and the present. He examines several nations' strategies and politics concerning the development of their tanks and tank forces.

A good source for studying tank warfare at the operational level is Michael Carver's The Apostles of Mobility: The Theory and Practice of Armored Warfare. This work looks at both the theory and practice of tank warfare, from the first conception of an armored vehicle to the establishment of the tank as the principal offensive weapon of modern land warfare.

## PERIODICALS

Brigadier General Samuel Rockenback provides a detailed discussion of World War I small tank unit tactics in his article "Tanks and Their Cooperation with other Arms." Rockenback details what tanks, infantry, and artillery forces learned tactically from World War I fighting and how future combined arms teams must fight on future battlefields.

In the article "Some Notes on Tank Development during the War," Colonel Sir Hugh Ellis discusses the purpose and function of World War I tanks and provides many British lessons learned about World War I tank development and fighting. This source focuses on lessons concerning tank mobility and reliability.

Major B.C. Chynowith provides information about tank functions and needed tank capabilities in his article "Tank Infantry." Chynowith focuses on the need for an infantry support tank that would aid the infantry in the close-in fight.

## PART II - WORLD WAR II

### BOOKS

In Modern American Armor, Steven Zaloga and James Loop study the development of US main battle tanks from World War II through 1980. This source provides a detailed discussion of how US main battle tanks were modified during this period and how the US tank development system works or does not work. Zaloga and Loop conduct a very objective analysis of US tank development and discuss deficiencies and who should be blamed for them.

Robert Joseph Icks' work, Famous Tank Battles, assesses the value of the tank in 20th century warfare. Icks details in graphics, narrative, and maps, 32 battles in which tanks played a dominant role. The book centers on World War II and discusses the impact of armor on warfare. Icks defines the "tank idea" as a principle of war.

The most critical examination of World War II tank performance is provided by John Ellis in his book The Sharp End. Ellis focuses his study on the tanks' limitations and conducts a thorough discussion of how vulnerable and unreliable World War II tanks were.

The best source for lessons learned concerning tank fighting in deserts is Liddell Hart's The Rommel Papers. Hart's editing and expansion of Rommel's World War II correspondence provides the reader an excellent insight of tank fighting in the desert and has multiple levels of lessons learned ranging from the single tank to division and army level lessons.

Liddell Hart again provides the reader with valuable lessons learned in his work The Other Side of the Hill. Through his post-war interviews with senior German officers, Hart reveals what the Germans learned about World War II tank fighting and provides a basis for German tank development and tactics.

War as I Knew It, by George S. Patton Jr., can be considered the best US source for lessons learned concerning World War II small tank unit tactics. Patton provides many lessons about how tanks should be employed and how combined arms operations should be conducted.

Tom Wintringham's Story of Weapons and Tactics is an excellent source of multi-national lessons learned. Wintringham establishes the tank fighting lessons learned for each major power of World War II and links some lessons to earlier armored warfare.

An excellent source for lessons learned is Janusz Plekalkiewicz's Tank War. Plekalkiewicz conducts a thorough examination of World War II and his work provides many pertinent

lessons learned by the Allies and Axis powers. His work addresses every facet of tank fighting and design.

Arms and Policy, by Hoffman Nickerson, contains many general or overall lessons learned concerning World War II tank warfare. This work focuses more on lessons learned about the principles for tank design than on small unit tactics and fighting.

Main Battle Tanks, by Rolf Hilmes, is a comprehensive look at the evolution of main battle tank technology from 1945 through 1986. Hilmes compares and traces the development of all current main battle tanks, including the M1A1, M60 series, T-72/64, Leopard I/II, Vickers and the Merkava. This source provides a detailed technical discussion of tank armament, munitions, fire control systems, powerplants, and survivability.

## PART III - ARAB-ISRAELI 1967 AND 1973 CONFLICTS

### BOOKS

The transcript of the briefing "Implications of the Middle East War on US Army Tactics, Doctrine, and Systems", by General William Depuy, contains many lessons learned from the Arab-Israeli 1973 tank warfighting. Depuy established several general or overall lessons learned and discusses each in detail, linking actual battles or situations to the lessons. This source focuses on protection, firepower, and command and control lessons.

"Lessons Learned from the Middle East Crisis", a memorandum written by the Office of the Assistant Chief of Staff for Force Development, was the best source of detailed lessons learned from tank fighting in the Middle East 1973 conflict. The memorandum provides lessons learned for all aspects of tank fighting and development.

Cham Herzog provides an excellent study of the Arab-Israeli 1967 and 1973 wars in his work Arab-Israeli Wars. Herzog's work focuses on the macro-level of the wars and several overall lessons about tank crew training and tank employment are provided.

The best US source for technical lessons learned and individual tank lessons learned is Walter J. Henderson's paper "Analysis of the Lessons Learned in the October 1973 Arab-Israeli

War." Henderson provides many technical design and capabilities lessons and relates how they have impacted on the US Marine Corps. He also establishes what lessons would not be applicable to US forces.

Nadav Sofran provides some valuable lessons learned during the "Six Day War" in his book From War to War: The Arab-Israeli Confrontations 1948-1967. Sofran begins his study with an analysis of the 1948 conflict and links the later conflicts concerning what the Israelis learned and how they have changed strategy and tactics based on their past experiences.

On the Banks of the Suez, by Avraham Adan, provides general lessons learned about tank fighting in the Sinai during the 1973 October War. This source discusses general characteristics that tanks need or already have that permit tanks to survive and win on the battlefield. Additionally, it provides a detailed account of the entire Israeli campaign in the Sinai.

The best Israeli source of lessons learned about the 1973 October War is David Elazar's Military Aspects of the Israeli-Arab Conflicts. Elazar examines every aspect of the October War and provides many valuable lessons learned ranging from morale and selection and training of tank crews, to technical lessons concerning tank design and capabilities, and finally to general lessons about tank tactics and fighting techniques.

## PERIODICALS

C.N. Barclay provides several general lessons about leadership, morale and the effects of technology in his article "Lessons from the October War," Army, March 1974. Barclay's focus is on lessons that made a significant difference on the battlefield.

The article, "Tank Myth or a Missile Mirage," Military Review, August 1976, by Charles Wakebridge, provides a detailed discussion of how tanks fared against the anti-tank missiles used during the 1973 October War. Wakebridge focuses his study on the Egyptian's use of the Soviet SAGGER and RG-7 and concludes that the guided missile can effectively neutralize a tank attack and that the tank has lost its dominance on the battlefield.

The best periodical sources for 1973 October War lessons are provided by Jac Weller in his articles, "Tanks in the Middle East," Military Review, May 1976 and "The Fight at Suez," National Defense, September-October 1974. Weller provides many lessons learned ranging from technical lessons about the tanks' power plants and weights, to more general lessons about tactics and procedures developed to defeat anti-tank missiles and overcome obstacles.

The article, "The 1973 Middle East War: An Engineer's View," The Military Engineer, November-December 1979, provides lessons concerning what kind of obstacles were employed in the

1973 October War to deny tank mobility and what engineering devices and procedures were developed to counter these obstacles and restore mobility.

Brigadier General Avigdor Kohalani's article, "Defense of the Golan," Military Review, October 1979, provides an excellent analysis of the vital lessons learned about how the Israelis conducted their defense of the Golan Heights during the 1973 October War. Kohalani focuses on the importance of terrain and how the defender should mesh his defensive positions with natural and man-made obstacles. He also discusses other general lessons concerning the training of tank crews and the tactical employment of tanks.

#### CHAPTER SUMMARY

The base of knowledge of tank warfighting and evolution is large and diverse. The books and articles listed in this chapter serve as the basis for information concerning what soldiers, engineers and historians have learned from past tank warfighting. The next two chapters of this study will provide a listing of the lessons learned and an analysis of the lessons learned gleaned from these sources.

## CHAPTER 3

### LESSONS LEARNED FROM PAST TANK WARFARE

This chapter provides the reader with a listing of lessons learned from 20th century tank warfighting experiences concerning tank and small tank unit mobility, firepower, protection, command and control, and overall design. The lessons learned will be derived through an examination of literature concerning major 20th century tank warfighting experiences and gleaning what soldiers, engineers, and historians have learned and documented about tank warfighting and overall performance. The major 20th century tank warfighting experiences that will be studied are World War I, World War II, and the Arab-Israeli 1967 and 1973 Wars.

This chapter will be divided into three parts: Part I - World War I, Part II - World War II, and Part III - Arab-Israeli Wars. Each part will further be divided into five areas: mobility, firepower, protection, command and control, and overall design. Under each area the reader will be provided with a list of lessons learned specific to that area and period of tank warfighting.

## PART I - WORLD WAR I

World War I can be characterized as a conflict in which technology dominated tactics. Technological advancements such as the machine gun, the railroad, and the telegraph combined to deny an attacker tactical and strategic offensive mobility. The combatives, after a quick race to the sea, settled into their trenches, erected their barbed wire fences and began four years of bloody, in-decisive trench warfare.<sup>1</sup>

Almost immediately, the British and French began looking for a way to restore battlefield mobility. On September 15, 1916, during the Battle of the Somme, the British introduced the tank to the battlefield. The French followed in August, 1918 by introducing tanks during the battle for Amiens. Initially, German high command reaction was to downplay the tactical abilities of tanks and not to pursue German tank development, but after further study, the high command decided that tanks were needed. In 1918, the United States followed the British and French lead and developed its own tank corps.

The World War I lessons learned concerning tank and small tank unit mobility, firepower, protection, command and control, and overall design are listed in the pages that follows.

## MOBILITY

### Obstacles

The major man-made obstacles used to deny tank mobility were ditches, land mines, barbed wire and concrete blocks.<sup>2</sup>

Tanks will need the capability to cross eight-foot-wide trenches and surmount four-and-one-half foot vertical obstacles.<sup>3</sup> A tank's center of gravity should be designed as low as possible and several inches in front of the longitudinal center to aid in spanning tank ditches.<sup>4</sup>

Tanks will need fascines (an enormous bundle of wood chained together) to be dropped into trenches to help tanks cross.<sup>5</sup>

Tanks will need to be able to climb a 45-degree incline. The tank's track will need long grousers (cleats) to climb steep slippery hills.<sup>6</sup>

Tanks are unsuitable for moving over wet, shell-churned ground.<sup>7</sup> Tanks are not capable of crossing battlefields that have been torn up by intensive artillery bombardment. Artillery can make terrain impassable to tanks by causing large craters, destroying natural drainage, and causing water to fill the craters, which can cause tanks to bog.<sup>8</sup>

The ability to cross through barbed wire is chiefly dependent on the presence or absence of angles that are likely to

hook and hold the wire. When wire becomes hooked, a tank's mobility becomes a question of the amount of wire and its strength against the tank's power.<sup>9</sup>

Tank mobility was significantly improved by the development and use of an "unditching beam" that could be fixed to the tank's tracks making self-unditching possible.<sup>10</sup>

### Speed

In all contests, the more agile and mobile opponents always have the advantage of being able to seize and keep the initiative.<sup>11</sup>

Tanks need to be faster. At Cambrai, tanks could travel only 4-6 mph on roads and less cross country. Tanks need to be faster in order to:

- increase shock effect.
- diminish opportunities for enemy escape.
- increase prospects of overrunning the enemy.
- make hostile fire less accurate.
- limit number of hostile shots.
- increase freedom in selection of point of assault.
- get to key terrain faster.
- deprive enemy of reaction time.
- increase chances of surprise.
- simplify ability to concentrate tanks.<sup>12</sup>

Tanks have to move at such speed as to escape the dangers of well aimed fires of heavy projectiles.<sup>13</sup>

Tanks need high road speeds to provide;

- strategic mobility.
- shorter road usage times.<sup>14</sup>

The primary objective is not high road speed, it is superior mobility. Superior mobility requires a very material reserve of power over the need for average conditions. This can be done by providing ample horsepower per ton, at least 20 horsepower per ton. A reserve of horsepower will also improve reliability and protect the engine from excessive depreciation and reduce need for overhauls.<sup>15</sup>

### Suspension

The tank's suspension is the keystone of vehicle efficiency. The suspension needs to absorb vibrations, bumps, and shocks caused by the roughness of the terrain. A tank's suspension needs to reduce bouncing and rocking and cause the hull to move in a straight line in spite of rough terrain. Suspension design should have:

- eight to twelve points of support (roadwheels).
- equalization (bogies, levers, or cables).
- elasticity (rubber road wheels, springs, buffers).
- dampening (shock absorbing devices).

-a sufficient and large compression amplitude  
(relationship of the rise and fall of roadwheels in relationship  
to the hull).<sup>14</sup>

### Track

Tank track is superfluous and undesirable for traveling  
long distances on good roads. A tank needs to have the dual  
capability of traveling on roads using wheels and cross country  
using tracks.<sup>17</sup>

Tank track must be wide enough to give an adequate  
supporting surface in relation to the aggregate weight of the  
vehicle. Ground pressure may be the determining factor as to  
whether a tank will get mired or pass over the terrain.<sup>18</sup>

### Range

Tanks need to travel longer distances prior to refueling.  
Initially, a tank's range was only 20 miles on roads and only 12  
miles cross-country. Later model tank ranges were improved to  
80-100 miles.<sup>19</sup>

## FIREPOWER

### Armament

Tank armament should consist of one anti-tank cannon and three to four machine guns inside the turret and one to two machine guns outside the turret.<sup>20</sup>

A tank's anti-tank cannon must be able to penetrate, at reasonable ranges, the armor of hostile tanks that it will most likely encounter. Weapons must have some margin of safety, for there may be little or no opportunity to change armament after the enemy has thickened his armor.<sup>21</sup>

The main gun needs to be effective against personnel.<sup>22</sup>

Tanks need as many machine guns as possible.<sup>23</sup>

### Features

Tanks should have rotating turrets to enable them to fire in all directions without having to change the direction of movement. The turret must rotate quickly and must be tightly fitted to the hull.<sup>24</sup>

A tank needs multiple turrets to permit firing in two directions simultaneously.<sup>25</sup>

## PROTECTION

### Against hostile fire

The most important protection for tanks lies not in their armor, but in their proper employment.<sup>26</sup>

The best defense against any and all methods of attack is constant movement, watchfulness, and a supply of smoke bombs to mask a tank if it is suddenly attacked.<sup>27</sup>

Tanks get safety from their mobility and near invisibility (make tanks smaller).<sup>28</sup>

It is not possible to armor against all hostile fire. No matter how thick the armor used, the enemy can employ a gun to pierce it. At a minimum, tanks should have armor protection against any sort of projectile from any weapon that a single soldier can carry about in its complete form.<sup>29</sup>

Tanks are highly vulnerable to the direct fire effects of artillery.<sup>30</sup>

### Crew and interior protection

Tanks can prevent numerous casualties through their ability to rapidly overcome strong defenses and to rapidly decide battles.<sup>31</sup>

Crews should be protected from the heat and fumes of the engine.

The crew compartment and engine should be separated and a means of putting out engine fires should be provided.<sup>22</sup>

Tanks need an effective interior fire extinguisher system.<sup>23</sup>

Dangerous projections inside the turret should be minimized and padded.<sup>24</sup>

The tank's entry and exit methods are poor and rapid evacuation is impossible.<sup>25</sup> Tanks need to have at least two hatches for the crew to enter or leave. Hatches should be located so that if the tank overturns, the simultaneous blocking of more than one hatch is highly improbable.<sup>26</sup>

The tank's fuel supply is vulnerable to enemy fire. The fuel supply is stored inside the hull and when ruptured fuel can fill the hull and the entire tank could catch fire.<sup>27</sup> The fuel supply should be separated from the crew compartment and enclosed with maximum thickness of armor.<sup>28</sup>

#### COMMAND AND CONTROL

##### Combined Arms Team

Tanks need infantry, artillery, and air to be successful. Working alone they suffer greater casualties.<sup>29</sup>

The British, French, and US believed that tanks met more than their match in contemporary anti-tank guns and therefore tanks could only be used in close liaison with infantry and artillery.<sup>40</sup>

Tanks need artillery to suppress anti-tank guns. A battery per 1000 meter front is recommended.<sup>41</sup>

Tanks need to have airplanes detailed to assist their maneuvers by augmenting artillery fires and providing information concerning enemy and friendly positions. A ratio of one plane per 1000 meters is recommended.<sup>42</sup>

The best air defense for tanks can be provided by attached anti-aircraft units.<sup>43</sup>

#### Employment

When tanks are employed in small numbers their effects are less and their casualties increase.<sup>44</sup>

Tanks are most effective when employed in depth and on a narrow front. Tank units need to have a reserve to exploit success.<sup>45</sup>

The ruling factor for tank success or failure is the selection of the terrain tanks are required to cross.<sup>46</sup>

Success depends on preparation. Leaders need to pick the best terrain and select exact routes.<sup>47</sup>

Tanks are an offensive agent for overcoming stubborn defense, for "breaking the square."<sup>48</sup>

The ability to exploit a successful attack is limited by the tanks' speed, range and reliability.<sup>49</sup>

Tanks should not attack at night.<sup>50</sup> Attacks should be limited to daytime due to limited visibility restriction inside the tanks.<sup>51</sup> Dawn is the best time to launch an attack. Tanks should concentrate the night before and attack at first light.<sup>52</sup>

Without the concealment of mist/smoke/night, slow moving tanks can easily be defeated by direct artillery fire or special super-powered anti-tank rifles.<sup>53</sup>

The best defense against a tank is another tank.<sup>54</sup>

When tanks attack, they need to surprise the defender to be successful. Future tanks need to have the ability to surprise.<sup>55</sup>

The employment of smoke is more important than potent shell. It is better to blind anti-tank gunners than to disrupt them.<sup>56</sup>

Do not use tanks as artillery pieces. It is a waste of their capabilities.<sup>57</sup>

When tanks meet the enemy, they are decisive.<sup>58</sup>

#### Communication, Control, and Training

Tank intercommunication is poor.<sup>59</sup> Tanks need radios to control their movements and fires.<sup>60</sup>

Tank crews need improved hand and arm signals to assist in controlling their movements and fires.<sup>61</sup> Tanks should have flags

for visual signals. Orange is the best flag color, then red. A protected opening should be provided to allow flag signals when the tank is buttoned up or under fire.<sup>42</sup>

Success depends on the training level of crews and units. Tanks, infantry, and artillery need to train together.<sup>43</sup>

Tanks should have map boards.<sup>44</sup>

Tanks should have a direction indicator to assist in navigation when buttoned up.<sup>45</sup>

### Visibility

Tanks allow limited observation from inside.<sup>46</sup>

Observation slits should be made of laminated glass that can easily and quickly be replaced when damaged.<sup>47</sup>

Due to limited visibility, tanks cannot hold ground.<sup>48</sup>

The wearing of gas masks interferes with the efficiency of the crew. All openings in the crew compartment should be made tight so that a slight increase in air pressure can be built up through the use of a power-operated blower that puts outside air through a gas protection filter and delivers it to the crew compartment.<sup>49</sup>

### Sustainment

Wear and tear and not enemy fire disables the majority of tanks.<sup>70</sup>

A continuous supply, maintenance, and salvage system is needed to maintain the momentum of a tank attack.<sup>71</sup> A supply tank is needed to carry ammunition and other stores.<sup>72</sup>

Leaders should expect tank losses of 25% for each attack. Replacement tanks will be required in considerable numbers.<sup>73</sup>

Tanks and crews can not sustain continuous combat beyond three days.<sup>74</sup>

## OVERALL DESIGN

### Capabilities

A tank's design should be based on its function.<sup>75</sup> A tank's tactical purpose is the first fundamental in its origin.<sup>76</sup>

Tanks should be able to stop, start, and turn suddenly and quickly without harm to the crew or vehicle. Controls should be handily located, easy to understand, operable with slight effort, and reliable.<sup>77</sup>

Tanks should be as quiet as possible and free from characteristic noises that would distinguish them from other types of motor vehicles.<sup>78</sup>

### Cost

A peacetime nation will never find the money for armored forces equipped with the best type of large expensive tanks. In peacetime equip the armored force with cheap and smaller tanks and plan for a change over when the fear of war looms and the nation's purse strings loosen.<sup>79</sup>

Tanks should be small and cheap and constructed almost entirely from commercial motor components. This will allow a large number of tanks to exist in times of peace, reduce the cost of the military, and facilitate rapid construction in the event of war.<sup>80</sup>

The French turned to new methods after learning a crucial lesson that a large number of small cheap machines stood a better chance of combining survival with success than a few heavy, expensive and less vulnerable tanks.<sup>81</sup>

### Types

A ground army needs two types of tanks. One type, to work with infantry, must be heavily protected with emphasis on firepower. The other type, to work with cavalry, must be light and fast with emphasis on range and mobility.<sup>82</sup>

Special tanks will be needed:

-A flame-gun tank will be needed to burn out pill boxes.<sup>82</sup>

-A mine rolling tank will be needed to counter minefields.<sup>84</sup>

-A bridge tank or amphibious tank will be needed to counter defensive positions established along rivers, canals, and trenches.<sup>85</sup>

Tanks are selge warfare weapons that serve a special purpose, breaking the trench stalemate.<sup>86</sup>

### Human Factors

Human factors need improvements. The interior of the tank is not comfortable. Inside it is very hot, the air is bad and the ride is uncomfortable. Crews are required to do maintenance in addition to fighting.<sup>87</sup>

A tank's interior space is determined by the room required by the crew to fire the armament. Gunners/guns should not interfere with each other. Gunners' firing positions must be level and free of obstructions. Gunners take less space standing than sitting or crouching.<sup>88</sup>

Crew size depends more on armament than anything else.<sup>89</sup>

Fairly comfortable crew seats should be provided for traveling purposes.<sup>90</sup>

Tanks are not able to store personal gear and additional equipment needed to sustain the fight. Space must be allotted for;

-ammunition

- radio
- personal equipment
- food, water
- gas protection devices
- spare parts and lubricants<sup>1</sup>
- tank basic issue items<sup>2</sup>

Tanks should have accessibility. They should allow easy access to all lubricating points, engine/transmission bolts, wiring, batteries, and power train elements. Assemblies should be removable with the greatest practicable ease and with minimum disturbance to other parts.<sup>3</sup>

#### Production

The most potent limiting factor for tanks is the difficulty in rapid production. In peace a nation needs few. During war a nation need thousands.<sup>4</sup>

Tank production is the tank's largest problem. It can take more than a year to produce a certain type tank.<sup>5</sup>

#### Weight

The weight and size of a tank must always be the minimum practicable. A large target, of great weight, is not desirable.<sup>6</sup> Weight (31 tons) caused tanks to ditch easily in the Flanders' mud.<sup>7</sup>

### Power Plant

The use of a diesel engine improves fuel economy and reduces the fire hazard.<sup>98</sup>

### Reliability

A tank should be designed to be durable and reliable, in spite of long wear and rough treatment.<sup>99</sup>

Tanks need to be more durable with fewer defects. There is a continual need to replace heavy pieces of machinery and tank efficiency is lost through rapid wear and tear.<sup>100</sup>

All power train parts (clutches/transmission reduction gears) should be strong enough to withstand the strain engine operation will put on them.<sup>101</sup>

Tanks are mechanically inefficient.<sup>102</sup>

## PART II - WORLD WAR II

World War II can be characterized as a global war involving multiple fronts, diverse battlefield terrain, extreme and divergent weather conditions, and numerous forms of battle ranging from the German blitzkrieg to the US island hopping campaign in the South Pacific.

Independent of front, terrain, weather or form of warfare, the tank quickly established itself as a weapon of decision, and nations rapidly reorganized their ground armies and developed tactics based on maximizing the mobility, firepower, and protection provided by armor formations and other mobile forces.

Throughout World War II tanks were involved in hundreds of battles and, when employed properly, significantly aided in deciding the victor.

The World War II lessons learned concerning tank and small tank unit mobility, firepower, protection, command and control and overall design are listed on the pages that follow.

## MOBILITY

### Obstacles

Tanks are of little use in the process of clearing a way through a minefield.<sup>102</sup>

Tank mobility can be restricted by enemy infantry defending from built-up areas along high speed routes of advance. Tanks can not fight effectively in built-up areas and must wait for infantry to clear them.<sup>104</sup>

Tank tracks can tangle with wire fences causing many tanks to throw or break track.<sup>105</sup>

There is no such thing as "tank country." Some types of country are better than others, but tanks have and can operate everywhere.<sup>106</sup>

Terrain can severely hamper mobility. In some battles, nearly half the tanks became bogged down due to unsuitable terrain. In European terrain, mud is one of the great dangers and the weight of the tank is its own worst enemy. It was not uncommon for tanks to churn themselves into the mud until only the turrets were visible.<sup>107</sup>

Artillery barrages can churn the ground and make it impassable for tanks.<sup>108</sup>

### Speed

Tanks are too slow.<sup>109</sup>

A tank's speed is of greater importance than its armor. Speed in exploiting the surprise will allow tanks to defeat other tanks that are superior in protection, armament and numbers.<sup>110</sup>

### Track

A track transport is needed for long road movements. It will save on tank wear and tear.<sup>111</sup>

Ice/snow can cause tanks to lose control and become giant toboggans. Rubber track pads should be used to provide traction on ice.<sup>112</sup>

### Range

Mobility is limited or based on the need to refuel the tank.<sup>113</sup>

## FIREPOWER

### Armament

The value of the main gun changed from being an infantry support gun to the additional role of "tank busting."<sup>114</sup>

Because of tank-proof defensive positions, tanks lost their shock effect and their firepower capabilities increased in importance. Tanks had to be able to fire effectively at any range up to the limit of direct visibility.<sup>115</sup>

Tanks need a high-explosive shell to defeat personnel and material.<sup>116</sup>

Superior armament can turn the tide in a tank battle.<sup>117</sup>

### Features

Tanks need 360-degree fire capability. Tanks should use rotating turrets to provide it. The limited traverse of the main gun on the M3 General Lee was a grave disadvantage.<sup>118</sup>

Tanks score a big advantage by being able to shoot and hit the enemy at a range at which the enemy could not hit back.<sup>119</sup> In European terrain, a tank is not often seen at greater ranges than 800 yards. Usually the range is much less. In the desert, tanks can be seen at a range of 2000 yards.<sup>120</sup>

In desert fighting, a tank equipped with long range armament is decisive.<sup>121</sup>

Tanks need rangefinders to aid gunners in determining ranges to targets, thus improving main gun accuracy. With a ballistic reticle, a tank has only a 5% chance of a first round hit at a range of 1500 meters. The stereoscopic rangefinder improved chances of a first round hit to 50% at 1500 meters.<sup>122</sup>

If a tank can disable an opponent while remaining outside the opponent's weapons ranges, or if a tank can penetrate the opponent's armor while the tank remains invulnerable, the tank will win.<sup>122</sup>

Tanks need a main gun stabilizer to permit a shooting on the move capability.<sup>124</sup> Tanks with a "fire on the move" capability have a demoralizing effect on the defender because moving tanks are harder for the defender to hit than stationary tanks.<sup>125</sup>

## PROTECTION

### Against hostile fire

Anti-tank guns are able to defeat a concentrated armor punch. To survive, tanks have to spar with anti-tank gun positions. When tanks encounter superior firepower, their concentrated, decisive thrusts will be limited to slow piecemeal engagements.<sup>126</sup>

A single anti-tank gun hit is often not enough to destroy a tank.<sup>127</sup>

The airplane has the capabilities to be the tank's deadliest foe.<sup>128</sup>

Moving tanks are harder to hit than stationary tanks.<sup>129</sup>

Tanks were destroyed by their opponent's weapons as follows:

- main gun/artillery accounted for 59.8% of the kills.

- mines accounted for 23.7% of the kills.

- bazookas accounted for 17.0% of the kills.<sup>130</sup>

Tanks were hit by their opponent's weapons as follows:

- 65% of all hits were in the tank's hull.

- 35% of all hits were in the tank's turret.

- 10% of all hits were in the tank's lower suspension<sup>131</sup>

Approximately 45% of all turret hits caused the tank to erupt in fire and completely burnt out the vehicle.<sup>132</sup>

Approximately 60% of all hull hits caused the tank to erupt in fire and completely burnt out the vehicle.<sup>133</sup>

#### Crew and interior protection

If a shell penetrates a tank and hits ammunition, it is almost certain to set the tank on fire.<sup>134</sup>

Ammunition, not fuel, is the primary fire hazard when a tank is struck by shot or shell.<sup>135</sup>

Tanks save lives.<sup>124</sup> The average number of crewmen killed per tank destroyed was 1.3. Approximately two to five per cent of crewmen deaths were caused by burns. Approximately 20% of crewmen casualties happened while the crews were off their tanks.<sup>127</sup>

### COMMAND AND CONTROL

#### Combined Arms Team

Tanks alone can not break through a prepared defense. Tanks need to fight integrated with other arms.<sup>128</sup>

The key to success for tanks and infantry is close cooperation. Infantry is needed to provide essential anti-tank protection.<sup>129</sup>

Tanks and infantry that do not train together will not be able to fight together. Combined infantry/tank training should be part of Army education.<sup>130</sup>

Close cooperation between tanks and aerial forces is essential. Communication must be established between forward ground tanks and air squadrons to enable air support within minutes. The airplane is the best tank-support auxiliary.<sup>131</sup>

Tanks' success hinge directly on the ability of artillery to destroy anti-tank guns. Split second adjustments of artillery fire can spell the difference between victory and defeat.<sup>132</sup>

Field artillery forward observers need to travel with tanks.<sup>143</sup>

Keep the same members of a combined arms team fighting together. Do not separate or interchange members.<sup>144</sup>

### Employment

Primary mission of armor is to attack infantry and artillery. The enemy's rear is the "happy hunting ground" for tanks. Use every means to get to it.<sup>145</sup>

Primary purpose of a tank is to be used to destroy unarmored men, and against the enemy's weakest position and position of these unarmored men. Its anti-tank purpose is secondary.<sup>146</sup>

Tanks should lead infantry when the terrain permits rapid advance and the enemy's anti-tank defenses are weak. Infantry should lead tanks when the terrain restricts movement and firepower or the enemy's anti-tank defenses are strong.<sup>147</sup>

The only way to successfully fight motorized formations is with tank formations.<sup>148</sup>

Tanks should avoid occupying isolated groups of trees in open country because the enemy will invariably target them with artillery and air fires. Tanks should disperse in open terrain.<sup>149</sup>

Because of improved anti-tank weapons, tanks can no longer expose themselves for long periods while within range of anti-tank

weapons. Tanks need to seek out the cover and concealment provided by the terrain and only expose enough of the tank to permit firing.<sup>150</sup>

The superiority of defensive firepower can be sharply limited by the ability of the attacker to concentrate suddenly and in great strength against any part of the defensive position.<sup>151</sup>

The tank does not fear the anti-tank gun; the tank fears the concealed anti-tank gun.<sup>152</sup> A concealed anti-tank gun is worth four tanks.<sup>153</sup>

Anti-tank guns are virtually invisible to tanks and endless opportunities exist for ambush and surprise. Tanks fighting in urban streets are at a serious disadvantage. Tanks should not fight in urban areas because:

- limited ammunition will not permit suppression or destruction of all likely anti-tank positions.

- tanks cannot clear enemy infantry from rubble or ruins.

- tanks will be in short grenade range of enemy infantry hiding in buildings along streets.<sup>154</sup>

Use of captured tanks can be disastrous because of:

- no replacement parts.

- different ammunition requirements.

- different weapon ranges.<sup>155</sup>

Tanks should never attack where the enemy expects them to come.<sup>156</sup> Tanks need to use their mobility to strike the enemy

using the longest way around or the indirect approach. Tanks should advance with the intent of avoiding the enemy's strength.<sup>137</sup>

Tanks should use secondary roads for routes of advance over primary roads because secondary roads are:

- less apt to be thoroughly defended.
- less apt to have demolitions on them.<sup>138</sup>

The main concern for tanks fighting in open desert is to bring the enemy under effective fire and start hitting him before he is in a position to hit back.<sup>139</sup>

The tank plays a decisive part in desert warfare because the desert contains no natural obstacles for it and no limitations on its use.<sup>140</sup>

Tanks can move with perfect impunity under time fire provided by either 105mm or 155mm projectiles. Use proximity or normal time fire to cover tank attacks.<sup>141</sup>

Terrain selection is essential for success. Terrain can make the mass employment of tanks impossible. Mountains, forest, waterways, and jungles can cause tanks to operate in dribs and drabs.<sup>142</sup>

### Command, Control, and Training

When radio communications break down, the commander will lose the ability to control his units.<sup>143</sup>

Leaders should command and control from a forward position in order to;

- improve troop morale.
- take advantage of momentary tactical advantages.
- speed decisions.<sup>144</sup>

Tanks need external phones to communicate with ground soldiers.<sup>145</sup>

Tank formations using a "peep" (recon jeep) can keep moving with minimum deployments.<sup>146</sup>

Tanks should fire at terrain which probably conceals anti-tank weapons. It is better for a tank to waste ammunition than risk its destruction.<sup>147</sup>

The rule for when to code or use clear concerning radio messages is: if the period of action is shorter than the period of reaction, use clear; otherwise use code.<sup>148</sup>

## Visibility

Tanks have limited visibility. Infantry using guerrilla tactics have the capability to "hand deliver" munitions that can destroy tanks.<sup>169</sup>

## Sustainment

More German tanks were disabled by wear and tear from long distance travel, improper dust filters, and immersion in mud than by enemy armor.<sup>170</sup>

Field repair and overhaul has to be set up near the front to prevent the loss of tanks for extended periods.<sup>171</sup>

Units in wartime will expend a six month peacetime supply of repair parts in a matter of a few days.<sup>172</sup>

The supply of replacement tanks has to be considered as important as ammunition resupply.<sup>173</sup>

To fight continuously tanks must be employed in relays due to crew fatigue and maintenance requirements.<sup>174</sup>

The average man could tolerate two to three tank burn outs. Few men withstood six to eight burn outs without mentally breaking down.<sup>175</sup>

## OVERALL DESIGN

### Capabilities

The US design attitude should change. The US's zeal for a reliable machine caused it to neglect the design of the fighting system. The US was more concerned with transmissions, suspensions, and chasis than with the design of armor protection and armament.<sup>174</sup>

Tank versus tank superiority depends on:

- main gun accuracy.
- rate of fire.
- speed and maneuverability.
- leadership/training/morale.
- radio contact.<sup>177</sup>

Tanks having superior armament and protection can offset significant quantitative superiority. On average it cost five U.S. Sherman M-4s or nine Soviet T-34s to destroy one German Panther.<sup>178</sup>

The most significant innovation in tank destruction was the small, close-range, individual soldier anti-tank weapon.<sup>179</sup>

The more tanks rely on infantry, artillery, and air to support their maneuvers, the more vulnerable tanks became to infantry, artillery, and air weapons. The more tanks have to rely

on firepower from air, infantry, and artillery, the less effective they become.<sup>120</sup>

The whole aim of the modern technique of war is to get men and weapons to effective points behind the enemy's main positions. Effect points are fuel trucks, ammunition, supplies, mechanics and staff that are behind or following the enemy's fighting vehicles.<sup>121</sup>

Tanks need to "eat the cake of heavy protection and have mobility too."<sup>122</sup>

Heavy tanks, like the 56-ton German Tiger, are not needed. What tanks lack in weight/protection is more than offset by improved mobility. History is full of examples of a small, agile army defeating a larger, less mobile one.<sup>123</sup>

Tanks are often required to carry infantry on the inside/outside of the vehicle. Tanks should be able to carry emergency supplies.<sup>124</sup>

In desert fighting, reliability, mobility, and size of the main gun are more important than the quantity of tanks.<sup>125</sup>

Tanks have limited capabilities and their role is severely restricted by;

- mechanical unreliability.
- unfavorable terrain.
- improved AT weapons.<sup>126</sup>

Tanks need to be able to swing around on their own axis.<sup>127</sup>

## Types

The British confirmed the need for two types of tanks. One is needed which emphasizes speed/range/mobility to perform cavalry type missions and one is needed which emphasizes firepower and protection to perform hard fighting.<sup>188</sup>

A universal tank is needed to fill both infantry and cavalry roles.<sup>189</sup> The ideal tank would be well protected, agile, powerful, and well armed.<sup>190</sup>

Special tanks are needed to overcome physical obstacles like concrete walls, pillars, pillboxes, and other fortifications. The other types of special tanks needed are;

- amphibious
- mine clearing
- ditch filling
- ground firming
- bridging
- flamethrowing
- missile launching
- searchlighting<sup>191</sup>

Flamethrowing tanks are very useful for attacks on houses, buildings, and concrete emplacements. The morale effect is tremendous.<sup>192</sup>

Amphibious tanks can be very useful. The US built 400 duplex drive tanks to supplement British amphibious tanks used in

the OVERLORD beach landings. The duplex drive tanks performed heroically on the OVERLORD beaches and estimates have them saving the lives of more than 10,000 Allied soldiers. General Eisenhower reported that without amphibious tanks, it would have been doubtful that the assault forces could have firmly established themselves.<sup>193</sup>

In guerrilla fighting, light tanks will be more important than heavy tanks because light tank will facilitate air delivery and require less fuel.<sup>194</sup>

#### Weight

The weight of armor cannot make up for lack of main gun power. Weight can only limit maneuverability and speed.<sup>195</sup>

Tanks weighing more than 40 tons will face considerable difficulties when being transported or crossing bridges. Any tank over 40 tons should be amphibious.<sup>196</sup>

#### Power Plant

Tanks equipped with aircooled, diesel engines proved very satisfactory. Diesel engines are better than gas engines because diesel engines have;

- better fuel economy.
- increased range.
- better reliability and less maintenance.
- reduced potential for fire.<sup>197</sup>

### Reliability

Large numbers of reliable tanks can achieve superiority over fewer but more sophisticated tanks.<sup>198</sup>

The inherent defects of machines severely limited tank performance. Tanks were not sturdy enough for war. Trackpins and other parts broke at alarming rates. Tanks in combat expended a six month peacetime supply of repair parts in a matter of a few days. Nearly 60% of all tank casualties were repairable;

- 80% of mine casualties were repairable.

- 40% of burned-out tanks were repairable.<sup>199</sup>

Dust was a great problem even when special filters were used.<sup>200</sup>

### PART III - THE ARAB-ISRAELI 1967 AND 1973 WARS

The Arab-Israeli Wars of 1967 and 1973 can be characterized as short, rapid conflicts dominated by maneuver and firepower. The weapons of decision initially were tanks and high performance aircraft, but the introduction of the missile (in air defense (SAMS) and anti-tank (ATGMs) organizations) to the battlefield ended the ability of the tank and the aircraft to dominate alone. In both conflicts, battles were fought over various terrain ranging from deserts to mountains, farmlands, and urban areas.

The weather conditions under which both conflicts were fought varied, with temperatures ranging from 130 degrees inside tanks fighting in the Sinai to below freezing temperature readings in the Golan Heights.

The size of battles ranged from individual tank and platoon sized defensive battles to division and army counterattacks.

The lessons learned from the Arab-Israeli conflicts concerning tank and small tank mobility, firepower, protection, command and control, and overall design are listed on the pages that follow.

## MOBILITY

### Obstacles

Minefields, ditches, and earthberms were extensively used to deny tanks the ability to move and concentrate.<sup>201</sup> Anti-tank ditches were five meters wide and two-and-one-half meters deep.<sup>202</sup>

### Speed

The future belongs to the faster tank. Tanks should rely on speed rather than on armor for protection.<sup>203</sup>

### Track

Wheeled tank transportation should be used to move track vehicles long distances.<sup>204</sup>

### Range

Tanks should be able to advance up to 60 miles a day in war conditions.<sup>205</sup> They should be able to cover 500 miles in the course of a campaign.<sup>206</sup>

## FIREPOWER

### Armament

Tank main guns are 10 times as lethal as their World War II counterparts. World War II main guns could hit only one out of 20 targets at 1,500 meters. Current main guns can hit between 10-15 out of 20 targets at 1,500 meters.<sup>207</sup>

The tank commander's machine gun needs to be able to effectively fight close-in infantry. The tank commander's machine gun needs to have a large ammunition storage capacity and be easy to load.<sup>208</sup>

Both the .50 caliber and 7.62mm machine guns are effective against high performance aircraft. Approximately 36 out of 100 ground kills were credited to machine gun fire.<sup>209</sup>

Armor piercing rounds are not effective against infantry. There is a need for a main gun anti-personnel round.<sup>210</sup>

High explosive anti-tank rounds are effective at ranges exceeding 4000 meters.<sup>211</sup>

There are not enough machine guns on tanks to suppress ATGMs.<sup>212</sup>

## Features

The tank that has a longer main gun range has an advantage. The Israeli' main gun outranged the Arabs' main guns by 400 meters. This enabled Israeli tanks to stand off and register hits without receiving any.<sup>213</sup>

The tank that has better main gun accuracy will decide battles.<sup>214</sup>

Tanks equipped with sophisticated sighting and stabilization systems will have a significant advantage over opponents not similarly equipped.<sup>215</sup>

Tank ammunition must still remain accurate even when the main gun is severely worn. The Israelis were required to fire 105mm ammunition from main guns worn out to 109mm.<sup>216</sup>

Most main gun hits in desert fighting are scored at ranges less than 1600 meters.<sup>217</sup>

## PROTECTION

### Against Hostile Fire

If a tank can be seen, the enemy will be able to hit it. If a tank is hit, chances of the tank being knocked out are very,

very high.<sup>218</sup> The battlefield is very lethal. In the 1973 War, or October War, the Arabs lost more than 2000 tanks and 500 artillery pieces in less than three weeks of fighting.<sup>219</sup> The Israelis lost more than 800 tanks during the same period.<sup>220</sup>

A tank can increase its chances of survival through its mobility. Quite simply, a moving tank is harder to hit than a stationary one.<sup>221</sup> The way to enhance a tank's protection is by adding speed and firepower while reducing weight and size.<sup>222</sup>

A tank using the terrain for cover and concealment doubles its chances of survival on the battlefield.<sup>223</sup>

Anti-tank (AT) weapons are more lethal than ever before and in very large numbers.<sup>224</sup> Approximately 20% of tank kills during the October War were caused by ATGMs.<sup>225</sup> The mass use of ATGMs can blunt armor attacks.<sup>226</sup> Tanks should expect ATGMs to be employed in mass from protected positions.<sup>227</sup>

ATGMs are more effective than tank main guns as the range to the target increases.<sup>228</sup> Tanks are more effective than ATGMs at ranges less than 1000 meters because:

- the tanks' main guns more accurate.
- tanks can fire faster.<sup>229</sup>

When fighting ATGMs at extended ranges (greater than 1000 meters), chances of survival are better if the tank uses the cover and concealment provided by terrain rather than trying to move. Movement by tanks at extended ranges is relatively unimportant in affecting the hitting ability of ATGM gunners.<sup>230</sup>

Anti-bazooka plates and external storage boxes can defeat some AT missiles or rounds.<sup>221</sup>

Close air support (CAS) is effective against tanks. The maverick missile recorded 42 direct hits out of 50 tries. "Smart bombs" hit 25 out of 32 targets.<sup>222</sup>

Tanks should use passive measures against enemy air attack. Armored forces should use small and dispersed trains, bunkers, and tank positions. Crews and tanks should be camouflaged. Tanks should use the terrain for concealment from air observation.<sup>223</sup>

#### Crew and Interior Protection

Unprotected fuel and oil containers are a fire hazard.<sup>224</sup> Storing main gun ammunition above the turret ring can result in secondary explosions and catastrophic kills of both tank and crew if turret is penetrated. Store all ammunition below the turret ring.<sup>225</sup>

A tank crew needs special fire resistant uniforms to prevent burns. NOMEX uniforms are effective in reducing burns. NOMEX should be modified as follows;

-sew up ventilation holes.

-double layers under forearms, buttocks, and outer thigh areas.

-NOMEX back of tank seats.

-need NOMEX gloves.

The combat vehicle crewman (CVC) helmet is effective protection if properly fitted. The padded interior of the CVC helmet needs to be fireproofed.<sup>234</sup>

Hydraulic fluid must be flame resistant or it will cause the tank to catch fire when the turret is penetrated.<sup>237</sup>

## COMMAND and CONTROL

### Combined Arms Team

It is essential to employ tanks as part of a combined arms team. Tanks need infantry, artillery, CAS, air defense and other support and service support elements to successfully operate.<sup>238</sup>

Unsupported tanks are at a definite disadvantage against ATGMs due to ATGMs' surprise and long range accuracy factors.<sup>239</sup>

Using infantry and artillery to suppress ATGMs can greatly reduce ATGM effectiveness.<sup>240</sup>

Without suppression of the enemy's air defense systems, close air support for tank maneuvers is impossible.<sup>241</sup> Ground forces must break up the enemy's SAM umbrella to use air with tanks.<sup>242</sup>

If CAS is not available, more artillery will be needed.<sup>243</sup>

### Employment

Diversified AT weapons have eliminated blitzkrieg tactics.<sup>244</sup>

It is impossible to ensure the success of any tank attack without destroying or silencing the ATGM defense in advance.<sup>245</sup>

Tanks should not engage ATGMs at long ranges. Tanks should move, using the cover and concealment provided by the terrain, to within 1000 meters of the ATGMs to take advantage of the tanks' better accuracy and rapid fire capabilities.<sup>246</sup>

In the defense, the ATGM is superior to the tank. An ATGM in a prepared and protected position will have an advantage over a tank even if the tank is supported by artillery and infantry.<sup>247</sup>

Tanks that move in open terrain may expose themselves to highly lethal long range ATGM and cannon fire. Movement must be covered or concealed or done when enemy AT weapons are being suppressed.<sup>248</sup>

Independent of mission (defend/attack), tanks must be able to move on the battelfield:

- The static defense is no longer viable.
- Tanks need the ability to suppress enemy firepower to allow movement.
- Tanks need the other members of the combined arms team to successfully suppress.<sup>249</sup>

Tanks need to shoot and move to confuse the enemy's indirect fires.<sup>250</sup>

Tanks should work in groups of eight to twelve vehicles. First, tanks should occupy hull down positions and observe, acquire the enemy, and destroy the acquired enemy. Then tanks should move and occupy different hull down positions and again observe, acquire, destroy, and move. Tanks should repeat the occupying, acquiring, destroying, and moving sequence at least three times from three different locations. This procedure will confuse the enemy's indirect and direct fires.<sup>251</sup>

High explosive and white phosphorus artillery rounds used in combination are successful in disrupting tank attacks. Leaders should use high explosive rounds to puncture the enemy's external fuel/oil containers and use white phosphorus rounds to set the fuel/oil afire, blind crewmen, and greatly degrade the enemy's morale.<sup>252</sup> In desert sand, use variable time fuses because point detonating fuses bury into the sand and lose some of their

The side that has the superior numbers of tanks on the battlefield has the advantage.<sup>252</sup>

The employment of captured tanks will be limited by lack of repair parts and ammunition.<sup>254</sup>

Tanks must be used in mass to be successful.<sup>255</sup>

The best defense is a good offense.<sup>256</sup>

#### Communication, Control, and Training

Close air support is not effective when the ground commander and the air commander can not communicate.<sup>257</sup> CAS is possible only after effective air/ground coordination.<sup>258</sup>

Tank forces will need trained observers to effectively control air/artillery fires. Untrained observers will be ineffective.<sup>259</sup>

The "people factor" can win over equipment superiority. Tank forces need skilled crews, good leadership, and good command and control procedures to succeed.<sup>260</sup>

The training level of individuals and crews can determine the difference between success or failure on the battlefield.<sup>261</sup>

Leaders can increase crew proficiency by:

- starting with high quality soldiers.
- increasing stability of assignments.
- emphasizing realistic live fire training.<sup>242</sup>

Tactical success depends on resourcefulness, innovation, and flexibility.<sup>242</sup> Leaders and soldiers must be trained to exploit success regardless of whether it was planned for in the operations plan or not. It is not enough just to be able to execute a rigid plan.<sup>244</sup>

The best tank is the one with the best crew.<sup>245</sup> To succeed against quantitatively superior forces, one needs a superior operative/skilled force.<sup>246</sup>

Leaders need to be far forward and emphasize mission orders.<sup>247</sup> The commander's order should be "follow me."<sup>248</sup>

Tank forces need an emergency vehicle identification radio frequency on the mobile battlefield to aid in preventing friendly forces from firing on other friendly forces.<sup>249</sup>

Tanks and aircraft need a rapid and positive method for identifying both friendly air and tank elements to aid in preventing friendly forces from firing on each other.<sup>270</sup>

When tanks are defending, they should use wire to communicate. When tanks are attacking, they should use FM radio to communicate.<sup>271</sup>

The use of fixed call signs by tank forces makes it easier for the enemy to pinpoint the command function at each command level. Vulnerability of radio communications can be a significant factor in the loss of battlefield commanders.<sup>272</sup>

Tanks need to be able to operate in an intense electronic warfare environment. Pre-arranged procedures will be needed to offset jamming.<sup>273</sup>

Without good morale, there can be no success in war.<sup>274</sup>

### Visibility

A buttoned up tank's limited visibility will force tank commanders (TCs) to open hatches to observe.<sup>275</sup>

Tanks should fight with the TC's hatch open or partially open to overcome visibility and target acquisition problems.<sup>276</sup>

During large night battles, the illumination created by burning vehicles, flares, and searchlights tended to minimize the value and degrade the effectiveness of passive vision devices.<sup>277</sup>

## Sustainment

The key to a successful maintenance effort is the forward use of area contact teams. Teams need to be tailored to meet the specific needs of the supported units.<sup>279</sup>

Basing class IX repair parts stockage on peacetime maneuvers will result in wartime shortages.<sup>279</sup> Extensive cannibalization will be needed to sustain operations.<sup>280</sup>

Recovery vehicles need cross country capability.<sup>281</sup>

Water and its protection are essential in the desert. Protect water by storing it inside the turret.<sup>282</sup>

## OVERALL DESIGN

### Capabilities

The tank is the single most important weapon on the mechanized battlefield. It must be designed to break through enemy defenses, get to his rear, destroy his communications, reserves, artillery, maintenance, and supplies.<sup>283</sup>

The future belongs to the faster, lighter tank armed with an ATGM of immense penetrating power. Tanks should rely on speed rather than armor for protection.<sup>284</sup>

The heavy, relatively slow tank is near the end of its career.<sup>285</sup>

A missile mounted on a tank is better than one carried by the infantry. A missile mounted on a helicopter is better than one on a tank.<sup>286</sup>

A tank that has a larger main gun basic load capacity has an advantage. Israeli tanks could carry between 63-70 rounds. Arab tanks could carry between 42-46 rounds.<sup>287</sup>

Large tanks are better than small tanks because;

- they can store more ammunition.
- they can contain better fire control systems.
- they are less tiring on crews.<sup>288</sup>

Small tanks are better than large tanks because of their lower silhouette.<sup>289</sup> A low tank silhouette is desirable because lower tank silhouettes are smaller targets and are easier to cover and conceal and harder to acquire and hit.<sup>290</sup>

The tank commander's cupola is not satisfactory because it;

- increases the tank's silhouette.
- interferes with machine gun operation.
- restricts vision.<sup>291</sup>

The tank commander's hatch needs to have the capability to be locked in three positions:

-fully open.

-partially closed, but leaving a 3-5 inch space between the tank and the hatch to permit 360- degree observation.

-fully closed.<sup>292</sup>

Tank ammunition needs to prolong, not degrade, main gun tube life. Adding lubricant to the ammunition powder charge can extend tube life four to five times.<sup>293</sup>

Tanks should have no external hardware such as searchlights, water cans, oil cans that are vulnerable to overhead artillery fires or small arms fire that will prevent the tank commander from bringing supporting air burst artillery onto his tank to suppress enemy infantry.<sup>294</sup>

Tanks need to be designed to minimize catastrophic loss. The battle damaged tank repair rates for the October War was:

British Centurions 60% returned to action

Soviet T54155 55% returned to action

US M48/M60 19% returned to action<sup>295</sup>

During the October War, every Israeli tank employed in the Golan Heights was hit at least once. Approximately 150 of 250 "knocked out" tanks were returned to battle after repairs.<sup>296</sup>

Tanks have the ability to detect and avoid long range slow moving ATGMs.<sup>297</sup>

A tank's mobility, armor, and firepower afford it both protection and the ability to move quickly from situations of dispersion to those of concentration and vice versa.<sup>298</sup>

### Types

Special tanks will be needed;

-minerolling or plowing tanks will be needed to counter minefields.

-bridge tanks or amphibious tanks will be needed to counter defensive positions established along rivers, canals, and trenches.<sup>299</sup>

### Human Factor

Poorly designed tanks can lead to early crew fatigue factor because of:

- excess fumes.
- excess heat.
- poor ventilation.<sup>300</sup>

### Production

Tanks cannot be produced on a short notice to react to emergencies. The main reason is component production. It can take as long as 19 months to produce some components.<sup>201</sup>

It is better to have or produce many low cost tanks than to have fewer more sophisticated expensive tanks.<sup>202</sup>

### Weight

Lighter weight means less track wear and better sand crossing capabilities. Lighter weight can improve maneuverability.<sup>203</sup>

### Power Plant

A tank's air cleaner system needs armor protection against artillery fragments and small arms fire. Penetrations will allow sand and dirt to enter air intakes and cause engine failure.<sup>204</sup>

## Reliability

Tank ammunition needs quality control checks. During the October War, more than 15,000 US sabot rounds were found to be unserviceable because of tumbling or skewing of the round.<sup>205</sup>

The more complicated the tank or system design, the harder it is to repair or field fix when broken.<sup>204</sup>

## CHAPTER SUMMARY

The list of lessons learned in this chapter is not all-inclusive. Further research may reveal other lessons that can be added. The lessons listed in this chapter will form the basis for the analysis and comparison in chapter 4 and the determination of the existence of a common thread of lessons.

## ENDNOTES

1. Richard M. Ogorkiewicz, Armoured Forces (New York: Arco, 1970), p.11.
2. Gifford Martel, Our Armoured Forces (London: Faber and Faber, 1954), p.38.
3. Hugh Elles, "Some Notes on Tank Development during the War", The Army Quarterly, April 1921, p.268.
4. Robert J. Icks and others, The Fighting Tanks Since 1916 (Washington D.C.: National Services, 1933), p.197.
5. Ian V. Hogg, Amour in Conflict: The Design and Tactics of Armoured Fighting Vehicles (London; Janes, 1980), p.31.
6. Icks and others, p.198.
7. Elles, p.270.
8. Hogg, p.31.
9. Icks and others, p.198.
10. Hogg, p.29.
11. Ogorkiewicz, p.4.
12. Icks and others, p.311.
13. B.C. Chynowith, "Tank Infantry," Infantry Journal, May 1921, p.507.
14. Icks and others, p.311.
15. Icks and others, p.186.
16. Icks and others, p.187.
17. Icks and others, p.191.
18. Icks and others, p.197.
19. Martel, Our Armoured Forces, p.38.

20. Icks and others, p.183.
21. Icks and others, p.184.
22. Macleod G. Ross, The Business of Tanks 1933 to 1945 (Elms Court: Stockwell Ltd, 1976), p.TBA
23. Kenneth J. Macksey, Tank: A History of the Armoured Fighting Vehicle (New York: Ballantine, 1971), p.45.
24. Icks and others, p.201.
25. Macksey, p.45.
26. Icks and others, p.311.
27. Martin Blumeson, The Patton Papers 1885-1940, (Boston: Houghton Mifflin, 1972), p.454.
28. Blumeson, p. 449.
29. Icks and other, p. 191.
30. Macksey, p.33.
31. Elles, p.270.
32. Icks and others, p.193.
33. Icks and others, p.193.
34. Icks and others, p.194.
35. Hogg, p.29.
36. Icks and others, p.201.
37. Hogg, p.29.
38. Icks and others, p.193.
39. Elles, p.279.
40. Ogorkiewicz, p.15.
41. Samuel Rockenback, "Tanks and Their Cooperation with Other Arms," Infantry Journal, January 1920, p.543.
42. Rockenback, p.543.
43. Icks and others, p.184.

44. Robert J. Icks, Famous Tank Battles (Gordon City: Doubleday, 1972), p.80.
45. Icks, p.80.
46. Elles, p. 271.
47. Macksey, p.33.
48. Elles, p.286.
49. Macksey, p.33.
50. Rockenback, p. 543.
51. Macksey, p. 33.
52. Rockenback, p.543.
53. Hogg, p.34.
54. Ernest D. Swinton, Eyewitness (London: Hodder and Stoughton Limited, 1932), p.30.
55. Elles, p. 64.
56. Icks, p.80 and Macksey, p. 33.
57. Rockenback, p.540.
58. Elles, p.270.
59. Chynowith, p. 507.
60. Martel, Our Armoured Forces, p.38 and Macksey, p. 40.
61. Icks and others, p.311.
62. Icks and others, p.203.
63. Icks, p. 80.
64. Icks and others, p.203.
65. Icks and others, p.203.
66. Hogg, p.29.
67. Icks and others, p.191.
68. Rockenback, p.450.

69. Icks and others, p.193.
70. Rockenback, p. 542.
71. Icks, p.80.
72. Peter Chamberlain and Chris Ellis, Fighting Vehicles (New York and London: Hamlyn, 1974), p.22.
73. Icks and others, p.312.
74. Icks, p.80.
75. Rockenback, p.450.
76. Icks and others, p.183.
77. Icks and others, p.202.
78. Icks and others, p.202.
79. Martel, Our Armoured Forces, p.4.
80. Martel, "Small Tanks and Cavalry," Cavalry Journal, July 1972, p.437.
81. Macksey, p.26.
82. Martel, Our Armoured Forces, p.39.
83. Macksey, p.43.
84. Chamberlain and Ellis, p.24.
85. Chamberlain and Ellis, p.24 and Martel, Our Armoured Forces, p.38.
36. Martel, Our Armoured Forces, p.39.
87. Icks and others, p.311.
88. Icks and others, p.194.
89. Icks and others, p.185.
90. Icks and others, p.194.
91. Hogg, p.25.
92. Icks and others, p.194.

93. Icks and others, p.202.
94. Icks and others, p312.
95. Rockenback, p.540.
96. Icks and others, p.183.
97. Hogg, p.29.
98. Icks and others, p.195.
99. Icks and others, p.201.
100. Elles, p.269.
101. Icks and others, p.311.
102. Chynowith, p.507.
103. Martel, Our Armoured Forces, p.220.
104. Tom Wintringham, The Story of Weapons and Tactics (Freeport: Books for Libraries Press, 1943), p 277.
105. Icks, p.279.
106. George S. Patton Jr., War as I Knew It (Boston: Houghton Mifflin, 1947), p.43.
107. John Ellis, The Sharp End (New York: Charles Scribner, 1980), p.127.
108. Ellis, p. 127.
109. Martel, Our Armoured Forces, p.157.
110. Liddel Hart, The Other Side of the Hill, p.125.
111. Ellis, p.126.
112. Ellis, p.127.
113. Hoffman Nickerson, Arms and Policy (New York: G. P. Putman's and Sons, 1945), p.264.
114. Martel, Our Armoured Forces, p.159.
115. Wintringham, p.208.
116. Hoggs, p.103.

117. Mildred H. Gillie, Forging the Thunderbolt, (Harrisburg: Military Service, 1947), p.209.
118. Peter Chamberlain and Chris Ellis, The Sherman (New York: Arco, 1969) p.8.
119. Martel, Our Armoured Forces, p.156.
120. Martel, Our Armoured Forces, p.156.
121. Liddel Hart, The Rommel Papers (New York: Harcourt, Brace and Company, 1953), p.185.
122. James Loop and Steven Zaloga, Modern American Armor (London: Arms and Armour Press, 1983), p.8.
123. Nickerson, p.250.
124. Hogg, p.84.
125. Janusz Plekalkiewicz, Tank War (Poole-Dorset: Blandford Press, 1986), p. 247.
126. Ellis, p.125.
127. Plekalkiewicz, p.298.
128. Plekalkiewicz, p.298.
129. Plekalkiewicz, p.247.
130. Icks, p.341.
131. Icks, p.341.
- 132.. Icks, p.341.
133. Icks, p.341.
134. Martel, Our Armoured Forces, p.147.
135. Higgs, p.84.
136. Gillie, p.268.
137. Icks, p.341.
138. Wintringham, p.205.
139. Ellis, p.137.

140. Gillie, p.256.
141. Plekalkiewicz, p.75.
142. Gillie, p.215.
143. Martel, Our Armoured Forces, p.148.
144. Gillie, p.279.
145. Patton, p.413.
146. Wintringham, p.209.
147. Patton, p.342.
148. Plekalkiewicz, p.47.
149. Patton, p.345.
150. Ellis, p.135.
151. Nickerson, p.265.
152. Martel, Our Armoured Forces, p.216.
153. Gillie, p.261.
154. Ellis, p.135.
155. Plekalkiewicz, p.77.
156. Patton, p.347.
157. Ellis, p.133.
158. Patton, p.348.
159. Hart, p.186.
160. Hart, p.185.
161. Patton, p.348.
162. Ellis, p.134.
163. Plekalkiewicz, p.75.
164. Plekalkiewicz, p.77.
165. Gillie, p.279.

166. Icks, p.341.
167. Patton, p.345.
168. Patton, p.348.
169. Wintringham, p.222.
170. Plekalkiewicz, p.134.
171. Plekalkiewicz, p.135.
172. Ellis, p.126.
173. Martel, Our Armoured Forces, p.148.
174. Nickerson, p.264.
175. Icks, p.341.
176. Martel, Our Armoured Forces, p.155.
177. Plekalkiewicz, p.77.
178. Plekalkiewicz, p.254.
179. Plekalkiewicz, p.297.
180. Chamberlain and Ellis, p.36.
181. Wintringham, p.227.
182. Gille, p.217.
183. Gille, p.262.
184. Gille, p.279.
185. Hart, p.185.
186. Ellis, p.125.
187. Martel, Our Armoured Forces, p.157.
188. Martel, Our Armoured Forces, p.147.
189. Hoggs, p.182.
190. Hoggs, p.82.
191. Martel, Our Armoured Forces, p.248.

192. Martel, Our Armoured Forces, p.306.
193. Gilille, p.279.
194. Wintringham, p.211.
195. Hart, p.185.
196. Martel, Our Armoured Forces, p.158.
197. Martel, Our Armoured Forces, p.157.
198. John Sanders, The Sherman Tank in British Service 1942-45, 1980, p.5.
199. Ellis, p.126.
200. Ellis, p.126.
201. Avigdor Kahalami, "Defense of the Golan," Military Review, October 1979, p.4.
202. "The 1973 Middle East War; An Engineer's View," The Military Engineer, November/December 1979, p.395.
203. Avaham Adan, On the Banks of the Suez (Presidio Press, 1980), p.469.
204. Nadav Sofran, From War to War: The Arab-Israeli Confrontation 1948-1967 (New York: Pegasus, 1969), p.353.
205. Sofran, p.353.
207. William Depuy, "Implications of the Middle East War on US Army Tactics, Doctrine and Systems", US Army Training and Doctrine Command, March 1975, p.10.
208. Walter J. Henderson, "Analysis of the Lessons Learned in the October 1973 Arab-Israeli War," Marine Corps Development Education Command, May 1977, p.C-324.
209. Memorandum, "The Lessons Learned from the Middle East Crisis," Department of the Army, Office of the Assistant Chief of Staff for Force Development, January 18, 1974, p.27.
210. Jac Weller, "Tanks in the Middle East", Military Review, May 1976, p.18.
211. Weller, " Tanks in the Middle East," p.21.

212. Jac Weller, "The Flight at Suez", National Defense, Sep/Oct 1974, p.133.
213. C. N. Barclay, "Lessons from the October War", Army, Mar 1974, p.28.
214. Weller, "Tanks in the Middle East," p.22.
215. Barkley, p.28.
216. Memorandum, p.6.
217. Weller, "Tanks in the Middle East," p.22.
218. Depuy, p.16.
219. Depuy, p.6.
220. Henderson, p.A-1-3.
221. Depuy, p.14.
222. Adan, p.469.
223. Depuy, p.4.
224. Depuy, p.2.
225. Henderson, p.C-3-24.
226. Cham Herzog, "Arab-Israeli Wars" (New York: Vintage, 1984), p.190.
227. Weller, "Tanks in the Middle East," p.21.
228. Depuy, p.12.
229. Depuy, p.13.
230. Depuy, p.16.
231. Memorandum, p.3.
232. Depuy, p.28.
233. Henderson, p.E-2-6.
234. Henderson, p.A-1-3
235. Henderson, p.C-3-24.

236. Henderson, p.I-1-9.
237. Memorandum, p.7.
238. Depuy, p.2.
239. Charles Wakebridge, "Tank Myth or a Missile Mirage," Military Review, August 1976, p.10.
240. Memorandum, p.1.
241. Depuy, p.28.
242. Henderson, p.E-1-7.
243. Memorandum, p.24.
244. Wakebridge, p.10.
245. Herzoz, p.26.
246. Depuy, p.13.
247. Wakebridge, p.10.
248. Henderson, p.C-3-27.
249. Depuy, p.4.
250. Weller, "The Flight at Suez," p.133.
251. Weller, "The Flight at Suez," p.133.
252. Memorandum, p.16.
253. Depuy, p.12.
254. Henderson, p.I-1-8.
255. Wakebridge, p.10.
256. Henderson, p.A-1-3.
257. Henderson, p.F-10.
258. Memorandum, p.24.
259. Memorandum, p.23.
260. Henderson, p.A-1-3.

261. Depuy, p.2.
262. Memorandum, p.4.
263. Henderson, p.F-54.
264. Barclay, p.28.
265. Weller, "Tanks in the Middle East," p.17.
266. David Elagar, Military Aspects of the Arab-Israeli Conflicts (Tel Aviv: University Publishing, 1975), p.247.
267. Henderson, p.A-1-3.
268. Sofran, p.350.
269. Henderson, p.F-10.
270. Henderson, p.F-10.
271. Henderson, p.F-10.
272. Henderson, p.F-54.
273. Henderson, p.F-54.
274. Barclay, p.26.
275. Sofran, p.350.
276. Memorandum, p.4.
277. Memorandum, p.18.
278. Henderson, p.I-1-6.
279. Henderson, p.i-1-7.
280. Henderson, p.I-1-8.
281. Henderson, p.I-1-8.
282. Memorandum, p.35.
283. Depuy, p.18.
284. Henderson, p.A-1-3
285. Wakebridge, p.11

286. Depuy, p.33.
287. Henderson, p.A-1-3.
288. Wakebridge, p.11.
289. Wakebridge, p.11.
290. Henderson, p.A-1-3.
291. Henderson, p.C-3-24.
292. Henderson, p.C-3-24.
293. Henderson, p.C-3-24.
294. Memorandum, p.2.
295. Memorandum, p.8.
296. Elagar, p.272.
297. Weller, "The Fight at Suez", p.133.
298. Adan, p.268.
299. "The 1973 Middle East War; An Engineer's View,"The Military Engineer, November/December 1979, p.395.
300. Henderson, p.A-1-3.
301. Memorandum, p.51.
302. Adan, p.469.
303. Weller, p. 16.
304. Henderson, p.C-3-24.
305. Henderson, p.C-3-24.
306. Memorandum, p.5.

## CHAPTER 4

### ANALYSIS AND DISCUSSION

This chapter provides the reader an analysis of the lessons learned from World War I, World War II, and the Arab-Israeli 1967 and 1973 Wars concerning tank and small tank unit mobility, firepower, protection, command and control, and overall design. Its purpose is to determine whether there is a continuous thread of lessons that can be considered common to these conflicts.

The analysis will be divided into five areas; mobility, firepower, protection, command and control, and overall design. If a common thread of lessons does exist in an area, a listing of the common thread lessons will be established at the end of the particular area analysis.

## MOBILITY

An examination of the lessons learned concerning tank mobility established the following common ground.

In the three conflicts examined, the major obstacles employed by the combatives to deny tank mobility were similar. The combatives attempted to deny tank mobility by constructing ditches, emplacing minefields, or using natural or man-made features such as rivers, mountains, or urban areas. In the three conflicts the consistency of the soil, whether it was the lowland mud of Flanders or the desert sand of the Sinai, could severely hamper tank mobility.

Concerning speed, the common lesson was that tanks should be fast. The common standard concerning how fast tanks should be was twofold; tanks should be fast enough to degrade the ability of enemy AT gunners to deliver accurate fire, and tanks should be faster than the enemy's tanks. The common tactical concept was that tanks should rely on speed rather than thick armor for battlefield survival.

Another common lesson was that tanks need an alternate method of moving long distances over roadways. Initially, a dual-capable tank was sought, one that could travel long distances using its wheel capability and, as it neared the battlefield, could stop and put on its tracks and fight the battle using its

track capability. After abandoning the dual concept idea, a wheeled tank transporter was designed. Wheeled or rail tank transportation was used extensively in both World War II and the Arab-Israeli Conflicts to move tanks long distances or from one front or theater to another front or theater.

The last common mobility lesson was that a tank's range, or need to refuel, serves as a limiting factor. In maneuver warfare the need to refuel tanks can have a significant effect on the campaign plan.

In summary, the common thread of lessons learned concerning mobility was as follows:

- 1) The major obstacles that will be used to deny mobility include ditches, minefields, barbed wire, urban areas, and natural features such as rivers, canals, and mountains.

- 2) The consistency of the soil, whether it be earth or sand, can severely limit a tank's ability to cross terrain.

- 3) The speed of a tank should be greater than the tank speed of its opponents and fast enough to degrade the ability of enemy AT gunners to hit the tank. Speed should be used to provide protection.

- 4) Tanks need an alternate method of moving long distances over roadways.

- 5) A tank's range, or need to refuel, will be a limiting factor on the maneuver warfare battlefield.

## FIREPOWER

An examination of the lessons learned concerning tank firepower established the following common ground.

A tank's main gun or anti-tank cannon needs to be able to penetrate or "bust" through the armor of its opponent. The requirement for accuracy at extended ranges, while not documented in the World War I lessons, was quite evident from the lessons learned during World War II and the Arab-Israeli conflicts. This need for accuracy at extended ranges was derived from the improved AT capabilities of the defender during World War II and the Arab-Israeli conflicts. Improved AT weapons took away the tank's ability to move within point blank range of trench systems, bunkers, and infantrymen as tanks did routinely during World War I engagements.

The lesson that a tank's main gun needs to have an anti-personnel capability serves as another common thread concerning main gun capabilities. The anti-personnel requirement grew in importance as the range of the enemy's AT weapons increased to outside the tank's machine gun ranges.

The need for multiple machine guns proved to be another common lesson. Machine guns are needed to destroy or suppress enemy infantrymen, anti-tank positions, combat support and service support personnel and equipment, and to defend against hostile

aircraft. The exact number of machine guns needed was not identified as a result of this research, but the rule "the more the better" appears applicable.

Another common lesson is that tanks need to have a 360-degree fire capability. While this lesson was not specifically documented in the Arab-Israeli conflicts, the fact that all tanks involved in the Six Day War and the October War had a 360-degree fire capability serves to reinforce the documented World War I and World War II lessons on the need for that capability and on the need for a turret to provide it.

In addition to all around fire capability, a tank needs the capability to engage in two directions simultaneously. While this need was documented only in World War I lessons, the fact that the vast majority of tanks that fought in later conflicts had and made use of this capability tends to support this need as a common lesson.

One lesson that did not appear in World War I, but should be considered common, was that technological advancements concerning the tank's fire control system, such as a rangefinder or stabilization, can provide a marked advantage by providing better accuracy at extended ranges or by providing a "shoot on the move" capability. It should also be noted that superior technology by itself is not enough to gain the advantage. It is equally important to develop and use exploitative tactical methods to take advantage of a tank's technological superiority. Without

the development and use of exploitative tactical methods, superior technology will lose much of its potential value.

In summary, the common thread of the lessons learned concerning firepower was as follows:

1) The tank's main gun needs to be able to penetrate its opponents' armor at extended ranges.

2) The tank's main gun needs to have an anti-personnel capability.

3) A tank needs multiple machine guns to destroy or suppress enemy close-in infantry, AT gunners, combat support and service support personnel and equipment, and provide anti-aircraft protection.

4) A tank needs a 360-degree firing capability.

5) A tank needs to be able to provide fire in two different directions simultaneously.

6) Superior technology, when coupled with tactical methods to exploit it, can provide a marked advantage.

## PROTECTION

An examination of lessons learned concerning tank protection established the following common ground.

The key to battlefield survival for tanks is based on their proper employment. Tanks must be allowed to fight in a manner that maximizes their abilities and takes advantage of the enemy's weaknesses. They must be allowed to maneuver using the cover and concealment provided by the terrain while supported by the firepower of other tanks or by other means (infantry, artillery, or air). Tanks must be allowed to fight at various ranges, dependent on the terrain and the enemy situation, with the aim of maximizing their speed, protection, extended main gun range, and rapid fire capabilities.

It is evident that the common lesson concerning the amount of armor protection afforded a tank is that a tank cannot be protected against all hostile fire. While not documented in the World War II and the Arab-Israeli lessons, the common lesson concerning the minimum amount of armor protection afforded a tank was that a tank should be provided enough armor protection to defeat all enemy AT weapons that can be carried on the battlefield by a single soldier.

The lesson that tanks saved thousands of soldiers' lives rang clear throughout the three conflicts. The protection tanks provide against indirect and machine gun fires and the tanks' abilities to destroy machine guns and quickly decide battles repeatedly caused tanks to be credited with saving thousands of lives.

The destruction and death caused by fire serves as another common thread lesson. Whether it was fuel fires in World War I, ammunition fires in World War II, or the combination of fuel, ammunition and hydraulic fluid fires in the Arab-Israeli conflicts, fire was the greatest destroyer of the tank and the greatest fear of its crewmen. Every aspect of tank design and capabilities should be examined with the aim of reducing the possibilities of fire.

The last common thread was that tank crewmen need special uniforms to provide protection against fire and other hazards unique to tank fighting.

In summary, the common thread of lessons learned concerning protection was as follows:

- 1) The key to battlefield survival is proper employment.
- 2) A tank cannot be protected from all hostile fire, but as a minimum, it should be protected with the aim of defeating all AT weapons that a single soldier can carry.
- 3) A tank should be designed with the aim of eliminating all possible fire hazards.
- 4) Tank crews need special uniforms to protect against fire and other hazards unique to tank fighting.

## COMMAND AND CONTROL

An examination of the lessons learned concerning tank command and control established the following common ground.

Tanks can not fight alone on the battlefield. They need to fight as part of a combined arms team consisting of infantry, artillery, air defense assets, air, and other combat support and service support elements. Infantry will be needed to kill or suppress enemy AT positions, clear urban and forested areas, and hold captured ground. Artillery will be needed to suppress enemy AT positions, provide smoke to conceal tank maneuvers, and suppress enemy air defense assets. Air defense elements will be needed to protect tank maneuvers from attacks by enemy air. Friendly air will be needed to gather information and augment artillery fires. Combat service support elements will be needed to provide continuous supply and maintenance trains to sustain combat operations. The combined arms team must be integrated into a force's structure at its lowest level. The individual tank or tank section, the individual infantryman or fire team, and the crew, section, and team leaders from the other combat support and service support elements must know how to fight or support based on the team's collective strengths and weaknesses. Additionally, the team must train or practice together to be successful in combat.

When tanks are employed as part of a combined arms team, their success depends on several factors;

- tanks must be used in mass.

- tanks must be concentrated in narrow sectors or points of enemy weakness.

- the selection of terrain must permit mobility and mass employment.

- the terrain must provide cover and concealment or other means must be employed, such as smoke/fire to suppress or blind possible and known enemy AT positions..

- tanks must be able to communicate with each other, other ground forces, and the air.

Another common lesson is that tanks are offensive weapons that should be used to destroy or counter strong defenses. While this purpose is common, the method of how tanks overcame strong defenses changed. During World War I, tanks could conduct frontal assaults and use their mobility, firepower and protection to close with and destroy infantrymen, machine gun positions, and artillery, thus destroying the defense. During the later stages of World War II and the Arab-Israeli 1973 War, superior AT weapons forced tanks to use the "long way" or "indirect approach" to cause the enemy to abandon his strong defensive positions in order to counter the tanks' movement. When engagements occurred, they were at long range and with the intent of destroying or bypassing enemy AT weapons in route to the enemy's rear area.

Poor tank visibility serves as another common thread. With hatches open tank visibility is limited, and when buttoned-up visibility is severely restricted. Limited visibility is the main reason why tanks, without the support of infantry forces, are not capable of holding ground. Due to limited visibility, enemy infantry can literally hand-deliver deadly munitions to tanks not fighting as part of a combined arms team.

A common lesson concerning tank movement is that tanks moving in open terrain and within range of enemy AT positions must either employ smoke to conceal themselves or effectively suppress enemy AT positions. Failure to do either will most likely result in the tank's destruction.

The common thread concerning control is that leaders must be well forward to effectively control tank maneuvers. Positioning leaders forward will permit them to better see the battlefield, enable them to quickly make decisions that can take advantage of an opportunity, and improve the soldiers' morale.

The common thread concerning sustainment is that the inability to provide continuous sustainment can be as deadly a foe as the enemy. Wear and tear will disable more tanks than enemy fires. Without an adequate supply of repair parts and forward located mechanics, tanks will not be mechanically able to fight. Fuel and ammunition must be provided on a continuous basis.

In summary, the common thread of lessons learned concerning command and control was as follows:

1) Tanks need to fight as part of a combined arms team. The combined arms team must be integrated and trained down to the individual, section, and squad level.

2) Tank success depends on several factors:

- mass
- concentration
- terrain selection
- communication

3) Tanks are offensive weapons that should be used to counter strong defenses.

4) Tank visibility is poor and ranges from limited (hatches open) to severely restricted (hatches closed).

5) Due to their limited visibility problem, tanks cannot hold ground without infantry support.

6) Tank movement must be concealed or conducted when enemy AT weapons are effectively suppressed.

7) Leaders must be well forward to effectively control maneuvers.

8) The inability to provide continuous sustainment can be as deadly a foe as the enemy.

## OVERALL DESIGN

An examination of lessons learned concerning overall design established the following common ground.

In all three conflicts, it was concluded that a tank's design should be based on its function or purpose. The function or purpose for tanks is twofold; to assist the infantry by providing a protected fire platform that could destroy or counter the enemy's strong defenses, and to provide the capability to concentrate quickly at a point of enemy weakness, penetrate his defenses and strike deep into the rear of his positions. These two purposes were constant throughout the study and they significantly contribute to the mobility versus protection aspect of design.

The need for special tanks also serves as common ground. Special tanks, such as mine rolling, bridging, and amphibious tanks, were successfully employed and made significant contributions on the battlefield.

The need for a fast, light, less sophisticated tank over a slower, heavy, more sophisticated tank serves as another common lesson. The essence of this common thought was on designing a tank that was fast enough and small enough that the enemy's anti-tank gunners or weapons probability of hit would be severely degraded, light enough to cross all types of soil consistency and cut down on wear and tear, and with a minimum of production time and cost.

Several factors concerning a tank's design and production were common to all of the studied conflicts.

(1) The cost factor played a major role throughout the conflicts and supported the concept of a smaller, lighter, less sophisticated, and cheaper tank over the larger, heavier, more sophisticated, and more expensive tank.

(2) The inability to rapidly mass produce tanks and the need for thousands of tanks was common to all three conflicts. This inability and need supports the smaller, lighter, less sophisticated tank design concept.

(3) The reliability factor supports the concept of having many tanks that are light and less sophisticated over the concept of having fewer tanks that are heavier and more sophisticated because lighter tanks have less wear and tear and less sophisticated tanks are easier to field fix or repair.

In summary, the common thread of lessons learned concerning overall design was as follows:

1) A tank's design should be based on its tactical purposes.

2) Special tanks will be needed. At a minimum, minefield breaching, bridging, and amphibious tanks should be provided.

3) The ideal tank would be light (less than 40 tons), fast (faster than opponents and with enough speed to

severely degrade enemy AT gunners' and weapons' probability of hit), less sophisticated (to speed production time and ease in field fixing and repair), and cheaper (to allow great numbers in peacetime).

#### CHAPTER SUMMARY

This chapter provided an analysis of the lessons learned from World War I, World War II, and the Arab-Israeli 1967 and 1973 Wars concerning tank mobility, firepower, protection, command and control, and overall design. The results of this analysis established a list of lessons that can be considered as a common thread and serve as a basis for the conclusions and recommendations provided in chapter 5.

## CHAPTER 5

### CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is threefold; to answer the research questions, to comment on the significance and contributions of the thesis and to make recommendations for future research.

This thesis focused on the question of the existence or non-existence of a common thread of lessons learned from 20th century tank warfighting concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design. The two research questions were;

(1) What were the lessons learned from 20th century tank warfighting concerning individual tank and small tank unit mobility, firepower, protection, command and control, and overall design?

(2) Does a common thread of lessons learned exist?

To answer these questions historical research was conducted of sources concerning the major 20th century tank warfighting conflicts; World War I, World War II, and the Arab-Israeli 1967 and 1973 Wars. The answer to the first research question is found in the multi-page lists of lessons learned in chapter 3 of this thesis. These lists of lessons learned are not all-inclusive, and the existence of additional lessons is highly probable. These lists served as the basis of the analysis and discussion presented

in chapter 4. The answer to the primary thesis question (the second research question) is that a common thread of lessons learned does exist. Lists of the common thread lessons and a discussion of each was presented in chapter 4 of this thesis. The lists of common thread lessons, like the lists of lessons that formed the basis for the analysis, are not all-inclusive, and the existence of additional common thread lessons is probable.

Support for these answers to the research questions is strong, and it comes from multiple sources. Lessons learned were gleaned from various sources including books, periodicals and US government documents. The authors of the sources were either actual participants in the tank warfighting experiences, professional historians or recognized subject matter experts concerning tank warfighting. The majority of the lessons learned were contained in more than one reliable source, few were controversial, and all lessons could be directly related to actual battles or combat experience.

The significance of this study is threefold: this research provides a basis of lessons learned that can be incorporated into the future organization, design and doctrine of US tank forces. This research should help prevent US tank forces from relearning costly past lessons on future battlefields. Finally, this research should serve as a foundation for additional research concerning tank warfighting lessons learned.

The contributions of this research to the source of knowledge concerning 20th century tank warfare are twofold. First, it compares and ties together what soldiers, engineers and historical researchers have learned and documented about 20th century tank warfighting. Second, it establishes a common thread of lessons learned concerning individual tank and small tank unit warfighting.

The recommendations of this thesis for future researchers are as follows:

(1) Research should be conducted with the aim of extending or expanding the lists of lessons learned in Chapter 3. If additional lessons can be documented then the lists of common thread lessons may be increased.

(2) Research should be conducted to determine whether current US tank design and capabilities incorporate the common thread of lessons learned.

(3) Research should be conducted to determine whether current US tank force organization and doctrine reflect or incorporate the common thread of lessons learned.

(4) Research should be conducted to determine whether the common thread of lessons learned has relevance in the warfighting experiences of the 20th century that involves smaller-scale tank warfighting.

## CHAPTER SUMMARY

This chapter has accomplished the following: it has answered the research questions, it has established the significance and contributions of the thesis to the body of knowledge, and it has made suggestions for further research and study.

## BIBLIOGRAPHY

### BOOKS

- Adan, Avraham. On the Banks of the Suez. New York: Presidio Press, 1980.
- Asher, Jerry. Duel for the Golan. New York: William Morrow and Company, 1987.
- Blumenson, Martin. The Patton Papers 1885-1940. Boston: Houghton Mifflin, 1972.
- Chamberlain, Peter and Ellis, Chris. Fighting Vehicles. New York and London; Hamlyn, 1974.
- \_\_\_\_\_. The Sherman. New York; Arco, 1969.
- Depuy, Trevor N. The Evolution of Weapons and Warfare. Indianapolis/New York: Bobbs-Merrill Company, 1980.
- Elagar, David. Military Aspects of the Arab-Israeli Conflicts. Tel Aviv: University Publishing, 1975.
- Ellis, John. The Sharp End. New York: Charles Scribner, 1980.
- Gille, Mildred H. Forging the Thunderbolt. Harrisburg: Military Services, 1947.
- Hart, Liddel. The Rommel Papers. New York: Harcourt, Brace and Company, 1953.
- Hart, Liddel. The Other Side of the Hill. London Cassell, 1973.
- Herzog, Cham. Arab-Israeli Wars. New York: Vintage, 1984.
- Hogg, Ian V. Armour in Conflicts: The Design and Tactics of Armoured Fighting Vehicles. London: Janes Publishing, 1980.
- Icks, Robert J. Famous Tank Battles. Gordon City: Doubleday, 1972.
- Icks, Robert J. and others. The Fighting Tanks Since 1916. Washington D.C.: National Services, 1933.
- Martel, Gifford. Our Armoured Forces. London: Faber and Faber, 1954.

Loop, James and Zaloga, Steven. Modern American Armor. London: Arms and Armour Press, 1983.

Macksey, Kenneth J. Tank: A History of the Armoured Fighting Vehicles. New York: Ballantine, 1971.

Nickerson, Hoffman. Arms and Policy. New York: G.P. Putman's and Sons, 1945.

Ogorkiewicz, Richard M. Armoured Forces. New York: Arco, 1970.

\_\_\_\_\_. Design and Development of Fighting Vehicles. New York: Doubleday and Company, 1971.

Patton, George S. Jr. War as I Knew It. Boston: Houghton Mifflin, 1947.

Plekalkiewicz, Janusz. Tank War. Poole-Dorset: Blandford Press, 1986.

Ross, Macleod G. The Business of Tanks 1933 to 1945. Elms Court: Stockwell Limited, 1976.

Sanders, John. The Sherman Tank in British Service 1942-45.

Sofran, Nadav. From War to War: The Arab-Israeli Confrontation 1948-1967. New York: Pegasus, 1969.

Stout, Wesley Winans. Tanks are Mighty Fine Things. Detroit: Chrysler Corporation, 1946.

Swinton, Ernest. Eewitness. London: Hodder and Stoughton Limited, 1932.

Winetringham, Tom. Story of weapons and Tactics. Freeport/New York: Books for Libianes Press, 1943.

#### GOVERNMENT DOCUMENTS

Depuy, William. "Implications of the Middle East War on US Army Tactics, Doctrine, and Systems," US Army Training and Doctrine Command, March 1975.

Henderson, Walter J. "Analysis of the Lessons Learned in the October 1973 Arab-Israeli War." Marine Corps Development Education Command, May 1977.

Memorandum, "The Lessons Learned from the Middle East Crisis,"  
Department of the Army, Office of the Assistant Chief of Staff  
for Force Development, January 18, 1974.

#### PERIODICALS

Barclay, C.N. "Lessons from the October War." Army, March 1974.

Chynowith, B.C. "Tank Infantry," Infantry Journal, May 1921.

Ellis, Hugh. "Some Notes on Tank Development During the War,"  
The Army Quarterly, April 1921.

Kahalami, Avigdor. "Defense of the Golan," Military Review,  
October, 1979.

Martel, Gifford. "Small Tanks and Cavalry," Cavalry Journal,  
July, 1927.

Patton, George S. Jr. "Tanks in Future Wars," Infantry Journal,  
April, 1920.

Rockenback, Samuel. "Tanks and Thier Cooperation with Other  
Arms," Infantry Journal, January 1920.

"The 1973 Middle East War: An Engineer's View," The Military  
Engineer, November-December, 1979.

Wakebridge, Charles. "Tank Myth or a Missile Mirage," Military  
Review, August 1976.

Weller, Jac. "Tanks in the Middle East," Military Review, May  
1976.

\_\_\_\_\_. "The Fight at Suez," National Defense, Sep/Oct  
1974.

INITIAL DISTRUBITION LIST

1. Combined Arms Research Library  
U.S. Army Command and General Staff College  
Fort Leavenworth, Kansas 66027
  
2. Major Siro Cappelletti  
CTAC  
USACGSC  
Fort Leavenworth, Kansas 66027
  
3. John Reichley  
Evaluation and Standards  
USACGSC  
Fort Leavenworth, Kansas 66027
  
4. Colonel Don Martin, Jr.  
1688 S. Garland Court  
Lakewood, Colorado 80226