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THE TANK-ATTACK HELICOPTER IN THE EUROPEAN MID-INTENSITY CONFLICT ENVIRONMENT: AN OPERATIONAL EFFECTIVENESS ANALYSIS OF COMPETITIVENESS/COMPATIBILITY

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

MASTER OF MILITARY ART AND SCIENCE

by

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1975

The Tank-Attack Helicopter in the European Mid-Intensity Conflict Environment: An Operational Effectiveness Analysis of Competitiveness/Compatibility

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The problem undertaken in this thesis is to determine whether or not the main battle tank or attack helicopter are competitive or compatible antiarmor weapons systems in a European mid-intensity conflict environment.

Due to the fact that the genesis of the problem is concerned with the quantitative armored superiority of the Warsaw Pact vis a vis NATO, two fundamental hypotheses were conceptualized, stated, and tested.

1. Can the defeat of mass armored forces be independent of force ratios?

and, if so

2. How can the U.S. Army attain a favorable exchange ratio, within existing funding constraints?

Pertinent to the findings of the operational effectiveness analysis of the M60A1 and TOW Cobra, the following conclusions are drawn relative to the tank-attack helicopter in the European mid-intensity conflict environment.

1. The main battle tank and attack helicopter are not competitive antiarmor weapons systems in that neither system affords a marked advantage over the other.

2. The main battle tank and attack helicopter are highly compatible weapons systems that are best employed using offensive principles where their mobility, firepower, and survivability can be optimized.

3. The bi-dimensional mobility capabilities and overlapping firepower characteristics of the main battle tank and attack helicopter are desirable and enhance the ability to achieve a favorable exchange ratio on the battlefield.

4. The main battle tank, complemented by the attack helicopter, will remain a decisive antiarmor weapons system for the foreseeable future.

ABSTRACT

The problem undertaken in this thesis is to determine whether or not the main battle tank or attack helicopter are competitive or compatible antiarmor weapons systems in a European mid-intensity conflict environment.

The genesis of the problem resides in the quantitative imbalance of main battle tanks that exists between the forces of NATO and the Soviet-led Warsaw Pact. This imbalance was assessed initially by comparing the Lanchesterian square law with direct empirical plots of historical win-loss results. It was determined that combat success can be independent of force ratios provided the numerically inferior force possesses a qualitative advantage.

From this juncture, qualitative advantage was measured by use of an operational effectiveness analysis model. In operationalizing this model, the systems design and combat performance of the M60A1 main battle tank and TOW Cobra attack helicopter were tested to determine if either was the superior antiarmor weapons system.

The overall conclusion drawn from the operational effectiveness analysis is that the main battle tank and attack helicopter are not competitive antiarmor systems in that neither affords a marked advantage over the other. Instead, they are highly compatible antiarmor systems that are best employed using offensive principles where their mobility, firepower, and survivability can be optimized.

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THE PROBLEM

INTRODUCTION

Since the inception of the tank over fifty years ago, the ambiguity of the tank-antitank battlefield has been the focus of numerous exploratory studies, developmental research inquiries, and strident debates. The inherent problem associated with this continuing ambiguity has been a form of tactical dissonance derived from a general confusion over the limitations of the tank and the inability to properly exploit its capabilities. As a consequence, each new development in antitank weapons and/or doctrine has sounded as the klaxon to alert military planners to the eventual demise of the tank. The advent of new antitank weapons systems has, however, functioned to resurrect the tank rather than to bury it. Each new antitank weapon did not become the doomsday machine of the tank. Instead, it served to make the tank designers and tank commanders more adroit and successful in the art of tank warfare.[1]

In regard to the tank-antitank battlefield, history has demonstrated its capacity to repeat itself. As in the past, the present is witnessing the advancement of a new panecea for eliminating the tank on the battlefield. This panecea has its roots in the parallel developments of the helicopter as an attack vehicle and a new generation of Tube launched, Optically tracked, Wire command link (TOW)

antitank guided missles. The juxtaposition of these two developments into the TWO Cobra helicopter weapons system has given credence, for the first time, to the vision of flying tank killers sweeping the tank from the battlefield.

As a result of this new dimension being added to the tank-antitank spectrum, the long standing debate regarding the obsolescence of the tank has been renewed. It is a debate that is not without emotion as old loyalties and new confront each other in dialogue.[2] For the advocates of airmobility, the attack helicopter represents the final resolution of the tank-antitank debate. For the protagonists, the attack helicopter represents a pipedream that will be quickly and devastatingly shattered by the reality of combat. Thus, it goes without saying that the warp and woof of the whole cloth will not become discernible until the attack helicopter is pitted against the tank in actual combat.

The professional soldier cannot, by the very nature of the responsibility entrusted to him, wait until that all conclusive moment in time. Instead, the professional soldier must, in the words of Major General Donn A. Starry, "...at least draw up some hypotheses to be tested, investigated, validated, or nullified in the search for more precise definition of the metes and bounds of tank-antitank war."[3] It is within this spirit that my research is undertaken.

BACKGROUND

The development of the present debate concerning tank-antitank warfare can best be understood and summarized in the convergence of

four independent trends. These trends are identified as:

1. the military development of the helicopter as a weapons system.
2. the shift in the strategic orientation of the United States.
3. the delimiting of the European tactical threat scenario.
4. fiscal constraints.

The Military Development of the Helicopter

During the past fifteen years, four catalytic events have given impetus to the current proposition that the helicopter poses a technological threat to armored warfare. The first of these was the establishment of the Rogers Board in 1960 to consider the Army Aircraft Development Plan and to review industry proposals. Although the more noted recommendations of the Rogers Board focused on observation, surveillance, and transport aircraft, a lesser known recommendation was made to the Department of the Army and Continental Army Command. This recommendation, which set into motion the first serious contemplation of the helicopter as a fighting vehicle, proposed that an in-depth study be conducted to ascertain "whether the concept of air fighting units was practical and if an experimental unit should be activated to test its feasibility."[4]

The second milestone in the military development of the helicopter came not from the military planners but from the civilian Secretary of Defense. In April 1962, Secretary McNamara sent a memorandum to the Secretary of the Army contending that the Army's aviation program was dangerously conservative, and declared that the Army needed to reassess its aviation requirements with a bold new look at land warfare mobility.[5] In summing up his desires, Mr.

McNamara declared:

> I shall be disappointed if the Army's reexamination merely produces logistically oriented recommendations to procure more of the same, rather than a plan for employment of fresh and perhaps unorthodox concepts which will give us a significant increase in mobility. 6

This benchmark in airmobility development not only functioned to sweep aside ultraconservative and doctrinaire resistance within the Army itself, but also provided the impetus for the establishment of the Howze Board in late April 1962.

The significance of the Howze Board resided in its major activity--field tests. They were conducted to compare a conventionally equipped force with an airmobile force.[7] The findings of the Howze Board determined that the helicopter could perform the five military functions of land combat--command and control, intelligence, combat service support, firepower, and mobility.[8] The Board further recommended the organization of the air assault division and a totally airmobile air cavalry combat brigade (ACCB) with an antitank capacity.[9] The Howze Board, therefore, validated the concept of combat helicopter organizations and gave conceptual birth to the 1st Air Cavalry Division (Airmobile) and the test ACCB which were established in 1965 and 1971, respectively.

The last event, which decreed the helicopter to be an integral part of the combined arms team, was the Vietnam war. The marked success of the helicopter in the Vietnam environment of low intensity conflict confirmed the combat capabilities of airmobility heretofore only imly seen by the early planners. As a consequence, the conceptual dimension of vertical combat became a functional reality.

The Strategic Orientation of the United States

During the administrations of Presidents John Kennedy and Lyndon Johnson, the strategic orientation of the United States was based on the belief that the most significant threats to American security were likely to come from insurgent wars. Therefore, President Kennedy put into motion the process of improving the military's capability for counterinsurgent operations and of intensifying counterinsurgency training.[10] In the setting of this strategic orientation and the growing success of the Viet Cong in the Republic of South Vietnam, President Johnson, in 1965, committed American military forces to the low intensity environment of the Vietnam insurgency. As a result of this strategic orientation, America's military focus throughout the decade of the sixties was primarily centered on Asia and wars of insurgency.

The pronouncement of the Nixon Doctrine in 1969 marked a fundamental shift in the locus of America's strategic orientation. Although the Nixon Doctrine continued to validate the strategy of flexible response, it stipulated a less active and direct American effort in military involvement on a global scale. Within this framework of the Doctrine, the Nixon administration concluded that American forces should no longer be maintained for the purpose of dealing with subversion or guerrilla warfare.[11] As a result, the disengagement of U.S. military forces from Vietnam was pursued in earnest, culminating in their complete withdrawal. The military impact of this course of action was clearly established by Lieutenant General Robert R. Williams, Assistant Chief of Staff for Force Development, Department of the Army, who, in 1971, acknowledged:

> We are transitioning from the conduct of a limited war of low intensity in the jungles of Vietnam to preparation for a conflict on the land mass of Europe. At least that is the contingency against which our force structuring and development programs are projected. 12

Thus, under the impetus of the Nixon Doctrine, America's strategic orientation shifted its focus to Europe for the first time in a decade.

The European Tactical Threat Scenario

The development of the European conflict scenario has been a product of both the conceptual and operational assessments of the Warsaw Pact threat. The conceptual assessment has been governed by the fact that the United States and the Soviet Union have now reached an age of approximate strategic nuclear parity. As a consequence of this parity, the United States has realized that without a credible conventional option, the defense of Europe would be totally dependent upon a strategic nuclear response. As recognized by America's leaders, such a strategic nuclear response would only invite mutual annihilation. Accordingly, the conventional force structure contained in the flexible response posture, enunciated by President Kennedy and nurtured by subsequent administrations, has been given renewed attention and emphasis. This requirement for conventional forces was stressed by former Secretary of Defense, Elliot Richardson, in his FY 1974 Defense Budget and FY 1974-1978 Program before the House Armed Services Committee in April 1973.

> It is essential that the U.S. and its allies have the option of an initial conventional defense. We should not place ourselves in a position where we are forced immediately and irrevocably to nuclear war in response to aggression against us. 13

In the era of nuclear parity, it is apparent that conventional forces are regarded as being more important, rather than less important. Thus, in relation to the spectrum of conflict, this conceptual assessment of the threat has functioned to elevate the prospects for mid-intensity warfare in Europe.

A Headquarters, Combat Development Command letter, dated 8 March 1971, stated that:

> ...the enemy encountered in a mid-intensity conflict would be a conventionally organized force capable of conducting operations as part of an identifiable national force, employing the latest doctrine, tactics, and techniques of land warfare. This force will likely have a highly sophisticated air defense system. 14

Current operational assessments of the Soviet-led Warsaw Pact threat in Europe exhibit a correlation with the aforementioned parameters of mid-intensity conflict. Indications are that the Warsaw Pact tactical plan appears to be based upon a short campaign to attack and break through NATO defenses, and to rapidly seize objectives deep in Western Europe.[15] The execution of this plan would be characterized by large armored forces employed in mass. The effectiveness of the armored forces, in turn, would be enhanced and protected by the integration of a highly sophisticated air defense system.

Within the context of both the conceptual and operational assessments of the Warsaw Pact threat, mid-intensity conflict is illustrative of the characteristics recently outlined by Major General Thomas M. Tarpley. For the purpose of this study, General Tarpley's delimitation of mid-intensity war is adopted as the common denominator for the European mid-intensity conflict scenario:

- Nonnuclear
- National Policy limitations
- Sophisticated environment
- Large armored forces
- Rapidly changing battlefield conditions.[16]

Fiscal Constraints

The last trend that impacts on the present tank-antitank debate is fiscal constraints. The decade of the sixties, which had begun with strong congressional and public pressure to improve American defense capabilities, left the seventies with a different legacy. This legacy was one of increasing public and congressional debate to reduce defense expenditures and to curtail American military involvement in the world.[17] Compounded to this legacy of the sixties, is the new legacy of the seventies. This legacy resides in the implementation of the all-volunteer force concept and inflation. In regard to the former, total manpower costs have risen dramatically. Despite the substantial reduction of almost 1.6 million military and civil service personnel from FY 1968 to FY 1974, total manpower costs were $11 billion higher. On the other hand, inflation has produced a debilitating effect on the purchasing power of the defense dollar.[18] The combined effects of these legacies are clearly reflected in the 1975 Defense Budget. For example:

- The Defense share of the Federal Budget at 27.2 percent of total Federal outlays represents a reduction of 15.3 percent from the FY 1968 peak of 42.5 percent. Additionally, it is the lowest level since 1950.

- The decline in the percentage of Gross National Product (GNP) devoted to defense is at its lowest level since 1950 at 5.9 percent.

- Defense represents 17.1 percent of new public spending, continuing its decline from the FY 1968 level of 29.2 percent.[19]

An even more revealing way to measure the impact of fiscal constraint on military spending is to examine the following data from the National Science Foundation relative to defense-related research and development (R&D).

Table 1

Summary of U.S. Research and Development (R&D) Funds by Sector (In billions of CY 1958 dollars) [20]

	Calendar Years				
	1953	1958	1963	1968	1972(est.)
Defense-related	2.8	5.7	6.6	7.0	5.5
All other	3.1	5.2	9.6	13.6	13.5
Total U.S. R&D	5.9	10.9	16.2	20.6	19.1

As depicted, defense R&D in 1972, in constant prices, was at a level below the level of 1958. Additionally, all of the real growth in the R&D resources of the United States since 1958--more than $8 billion--has been applied to civilian activities.[21] Therefore, the frequently made charge by a growing number of defense critics that "defense R&D has dominated federal--and national--R&D funding since the post-World War II years" is certainly no longer true.[22]

Compounded to the trend that the allocation of U.S. R&D resources has been primarily directed toward the civilian sector, is the impact of inflation. Inflation has further eroded R&D resources for the military sector. The purchasing power of R&D and procurement in constant fiscal 1970 dollars has declined from approximaely 25

percent of the fiscal 1970 budget to just 17 percent of the fiscal 1975 budget. In the fiscal 1975 budget, our resource levels for R&D and procurement represent only two-thirds of the purchasing power of five years ago; and, of the fiscal 1975 budget, measured in fiscal 1970 constant dollars, almost one-half goes to escalation.[23]

The erosive impact of inflation is clearly illustrated by zeroing in on procurement only for fiscal 1970 and fiscal 1975. In a time of declining total procurement dollars, over $900 million, or approximately 30 percent, has gone to cost escalation.[24]

Even a cursory statistical analysis clearly establishes the fact that each Service, in preparing for the threat of a mid-intensity conflict in Europe, must consider the fiscal reality of scarce resources resulting from a recalcitrant American public and Congress, as well as rising costs. For as Defense Secretary James R. Schlesinger stated in a 1974 interview:

> Looking ahead to the future—in terms of actual purchasing power, we have at best a set amount of money to do the job. The resource barrel will be relatively fixed in size. And you have to be an optimist to interpret the figures even that positively. A more realistic assessment might be to conclude that we are actually saddled with a decreasing budget. 25

In summary, the significance of these four independent trends resides in their present convergence. For through their contiguity and interface with each other, they have served to renew the tank-antitank debate.

RESEARCH PROBLEM

The Warsaw Pact threat doctrine and organizational emphasis indicate that defense against mass armored forces will play a de-

cisive role in any European mid-intensity warfare. The fact that armor is the heart and soul of the Soviet-led Warsaw Pact doctrine and tactics is clearly reflected in the writings of Soviet military leaders. Marshal T.Z. Rotmistrov, Marshal of Tank and Mechanized Troops has contended that:

> Only armor can assure the rapid and total destruction of the enemy and that it alone can achieve swift and decisive victory under modern conditions. Therefore, armor is the basic maneuver element of the Soviet Army. Tank forces play the decisive role in the attack. 26

This view of Soviet doctrine and tactics has been further established and corroborated by Colonel A.A. Sidorenko, Doctor of Military Science and faculty member of the Frunze Military Academy. In his work entitled The Offensive, he states that:

> ...[all] offensive actions will be conducted primarily on tanks...Battles in dismounted combat formations are only where the enemy offers strong resistance and where the terrain hinders the actions of the maneuver battalion on vehicles. 27

As reflected in the 1962 publication, Military Strategy, the tactical importance of armor has not been confined to the present decade. This authoritative book on Soviet military thinking, a product of fifteen leading Soviet military theoreticians headed by Marshal Vasily Sokolovsky, Chief of the General Staff from 1953 to 1960, unequivocably declares that:

> An offensive should be mounted using primarily tanks, and armored troop carriers. Dismounted attack will be a rare phenomenon. Mechanized firepower and maneuvers of troops in vehicles will now reign on the battlefield. 28

Thus, armor has been, and will continue to be, a constant of Soviet doctrine and tactics.

In addition to the doctrinal emphasis on armored forces,

the Soviet-led Warsaw Pact nations possess a significant quantitative superiority in main battle tanks vis a vis the U.S.-led NATO forces. A rudimentary comparison of main battle tanks in Europe discloses the stark reality that Soviet armor by itself is nearly double that of the NATO forces, to include the two U.S. armored divisions located in Central Europe. Comparatively, the Soviet-led Warsaw Pact forces possess over 14,000 main battle tanks to NATO's 5,500 affording them a 3:1 advantage.[29]

Defense against mass armored forces will dominate defensive considerations and combat in Europe, in that they are likely to be encountered everywhere and at anytime. Due to this ubiquitous presence on the battlefield, fighting against tanks and their destruction has become the primary concern and mission orientation of U.S. and NATO forces for the defense of Europe.[30] Consequently, NATO military theorists have adopted the tenet that "...the modern defense is first the battle against enemy tanks; therefore, it should first be organized as an antitank defense."[31]

All of this points to the fact that the fundamental concern confronting NATO in a mid-intensity European conflict is the problem of effective antiarmor defense. Any failure to counter the massive armor threat of the Warsaw Pact nations holds forth two undesirable consequences. The first consequence is the destruction of NATO forces in Europe by massive armored forces, whether either side does or does not employ tactical nuclear weapons. The second consequence is the macabre option of a strategic nuclear response by the U.S. against the Soviet Union as a final recourse to defend Western Europe. It is rather evident, then, that the basic research problem can best be

summed up by the succinct analysis contained in a Warsaw Pact study: "The number one mission today is to repel and stop tanks."[32]

As early as 1932, British Major General J.F.C. Fuller published a series of lectures which grappled with the problem of how to repel and stop tanks. In essence, General Fuller contended that linear oriented defense was not applicable to a battlefield characterized by armored warfare. The reason cited was that the tank can penetrate a defensive line and maneuver in all directions.[33] Instead, General Fuller advanced the tactical proposition that:

> The types of defenses required are such as will either prevent a breakthrough or stop its exploitation. They should be as deep as possible, not only in order to frustrate penetration, but if it is effected, to make it as costly as possible. 34

This tactical proposition of antitank defense in-depth, was affirmed by the Soviets during World War II. In 1941, the Soviets had an average of only one to three antitank guns per kilometer of front and they were emplaced only to a depth of three to five kilometers. However, through the lessons of experience and defeat, the Soviets, by the end of the war, were employing 20-25 antitank guns per kilometer of front, echeloned 30 to 50 kilometers in-depth.[35]

The validity of both General Fuller's defensive concept and the Soviet experience have been attested to in the 1973 Tactical Helicopter Employment Study (THES). This study concludes that the fulcrum of antitank defense rests on the ability to destroy enemy armor at the greatest possible distance from friendly positions and to engage the surviving armor with an increasing number of antitank weapons.[36]

The obvious conclusion of these various examples is twofold:

(1) The key to antitank warfare is defense in depth.

(2) Antitank defense in-depth, by its very nature, requires a proliferation of antitank weapons.

In regard to these conclusions, however, one must juxtapose present U.S. military doctrine which states that the best defense against a tank is another tank. For even though the tank is being challenged by such antiarmor weapons as the TOW and Dragon, the special text published by the U.S. Army Infantry School, which focuses on the destruction of enemy armored formations, states in its introduction that "...the tank remains the decisive weapon on the battlefield."[37] Thus, doctrinally, the tank still is the basic building block for any antiarmor defense. Considering the trend of increasing fiscal constraints on the military, however, the task of developing an effective antiarmor defense is no longer the mundane matter of purchasing and shipping 8,000 more main battle tanks to Europe. The U.S. Army has had to concede that it can no longer purchase as many weapons systems as it requires. The genesis of the research problem, therefore, resides in the paradoxical dilemma that the quantity of main battle tanks required by a modern antiarmor defense dictates a degree of capital outlay which is totally unacceptable in an era of fiscal repression.

PROBLEM STATEMENT

With technology advancing the prospect that it may be the panacea for overcoming the problems that confront mankind today, it is not surprising to find that it is being proffered as the solution to this particular dilemma. Many defense officials now contend or agree that the Army must apply technology to reduce costs

as well as to increase mission performance. As a consequence, the position has been advanced that helicopter technology provides the means for reducing costs while increasing antiarmor capabilities. Many have concluded and argued that "the attack helicopter is a relatively cheap, flexible, and highly potent weapons system,"[38] and, as such, constitutes a challenge to the antiarmor role of the main battle tank.

The Main Battle Tank Task Force Study, however, has acknowledged the fact that the main battle tank and attack helicopter are each high cost items that perform similar functions. In consideration of this finding, and the existing cost constraints that have forced the Army to scrutinize its weapons system as never before, a fundamental issue concerning the mid-intensity mission relationship of these two antiarmor weapons systems is the question of whether they are competitive or compatible. Guided by the dictates of cost, competitiveness inveighs the elimination of one system over the other. Within this context, the superior system must be doctrinally ascribed the primary role for the destruction of armor and be given priority for development and procurement. On the other hand, compatibility posits a degree of interdependency that suggests a dual, but complementary development of both systems. In this regard, doctrine and procurement should be adjusted to reflect their commonality of roles in consideration of their peculiar capabilities. Thus, the problem succinctly stated is:

IN THE MID-INTENSITY CONFLICT ENVIRONMENT
OF EUROPE, ARE THE MAIN BATTLE TANK AND ATTACK
HELICOPTER COMPETITIVE OR COMPATIBLE WEAPONS SYSTEMS.

PURPOSE OF STUDY

The purpose of this study is directed toward resolving the question of competitiveness and compatibility by determining whether or not the attack helicopter provides the optimum solution for modern antitank defense in the European mid-intensity conflict environment. In this regard, the resolution of the research problem appears to focus on two hypotheses. The first and most inchoate hypothesis to be tested is oriented toward the question of quantity versus quality:

CAN THE DEFEAT OF MASS ARMORED FORCES
BE INDEPENDENT OF FORCE RATIOS.

The second hypothesis to be analyzed is a product of the drastic curtailment of resources allocated for defense spending:

IN ORDER TO ATTAIN A FAVORABLE EXCHANGE
RATIO WITHIN EXISTING FUNDING CONSTRAINTS,
THE U.S. ARMY SHOULD REPLACE THE MAIN
BATTLE TANK WITH THE ATTACK HELICOPTER
AS THE PRINCIPAL ARMOR DEFEATING SYSTEM.

CHAPTER I

FOOTNOTES

1. Kenneth Mackey and John H. Batchelor, Tank: A History of the Armored Fighting Vehicle (London), p. 126.

2. MG Donn A. Starry, "Observations of the Tank-Antitank Battlefield," Armor, January-February 1974, pp. 4-6.

3. Ibid.

4. LTG John J. Tolson, Airmobility 1961-1971, Vietnam Studies, (Washington, D.C.: Department of the Army, 1973), pp. 8-9.

5. Ibid.

6. Ibid.

7. Ibid.

8. Captain R.J. Cohen, Canadian Land Forces, "Helicopter - Panacea or Pipedream?," The Army Quarterly and Defense Journal, July, 1973, p. 430.

9. Tolson, op. cit., p. 22.

10. Morton H. Halperin, Defense Strategies for the Seventies (Boston: Little, Brown and Co., 1971), p. 50.

11. Ibid., p. 51.

12. LTG Robert R. Williams, "A Time for Transition," Army Aviation, Vol. 20, 31 December 1971, pp. 13-14.

13. Annual Defense Department Report FY 1974, (Washington: Government Printing Office, 1974), p. 5. (This report is hereafter cited as ADDR74.)

14. BDM Services Company, Tactical Helicopter Employment Study (THES) Vol. II (Monterey, California, November 1973), pp. A-4.

15. MG Leslie W. Bray, "Tactical Counterforce," Air Force Magazine, June 1974, p. 38.

16. MG Thomas M. Tarpley, "Mid-intensity Warfare," U.S. Army Aviation Digest, July 1974, p. 3.

17. Halperin, op. cit., p. 53.

18. ADDR74, op. cit., pp. 6-7.

19. "Defense Budget for 1974," Commanders Digest, March 15, 1973 pp. 2-3; see also "Defense Budget FY 1975," Commanders Digest,

March 7, 1974, pp. 3-4.

20. Frederick Seitz and Rodney W. Nichols, Research and Development and the Prospects for International Security (New York: Crane, Russak & Company, 1973), p. 21.

21. Ibid., p. 20.

22. Ibid., p. 19.

23. Hon. Herman R. Standt, "The Army Looks Ahead," National Defense, September-October 1974, p. 123.

24. Ibid.

25. Ibid., p. 126.

26. MAJ Nicholas P. Vamvakias, "An Analysis of the Russian Armor Threat Facing U.S. Forces in Central Europe and a Determination of How to Counter this Threat During the 1971-1980 Time Period," Commaand and General Staff College Student Paper, April 1971, p. 5.

27. A.A. Sidorenko, The Offensive (A Soviet View) (Moscow, 1970), p. 59.

28. Marshal V.D. Sokolovsky, ed., Military Strategy, Soviet Doctrine and Concepts (New York: Frederick A. Praeger, 1963), p. 292.

29. Vamvakias, op. cit., pp. 11, 12.

30. Maj. I.G. Rolf A. Huettel, Deutsch Bundeswehr, "Defense Against Armor in the German Army," Armor, September-October 1970, p. 38.

31. Sidorenko, op.cit., p. 531.

32. U.S. Army Foreign Science and Technology Center, Stop the Tanks (Country: Czechoslovakia) (Washington: November 1969), p. 22.

33. Major L. Wayne Kleinstiver, "The Archipelago Defense," Infantry, March-April 1974, p. 27.

34. Ibid.

35. Strategy and Tactics, Simulations Publications, June-July 1974, pp. 6-20.

36. BDM Services Co., op. cit., pp. A-6.

37. U.S. Army Infantry School, "Antiarmor Tactics and Techniques for Mechanized Infantry," ST 23-3-1, Ft. Benning, Georgia, 1974, pp. 1-2.

38. Wing Commander T.S.C. Jones, AFC, RAF, "The Attack Helicopter in Close Support," The Royal Air Force Quarterly, Vol. 13, No. 2 (Summer 1973), p. 127.

CHAPTER II

REVIEW OF RELATED LITERATURE

OVERVIEW

In undertaking the challenge of testing the hypotheses central to this study, the researcher is inundated with a voluminous quantity of studies and tests concerned with the tactical role of the helicopter. The enormity of this problem is reflected in the Tactical Helicopter Employment Study (THES). Although it reduced an estimated 60,000 pages of material pertinent to the tactical helicopter to one source reference, it still comprises eight volumes with over 5,000 pages. Therefore, the rudimentary task of the researcher is one of discerning that which is relevant to his particular inquiry.

In the interest of delimitation and refinement of focus, the review of existing research studies has been confined to those benchmark studies that test the criteria of consistency and resiliency. For when subjected to the tests of time and changing tactical scenarios, a concept is valid only if its generalizations remain constant. In this regard, the following studies are considered to represent benchmarks in the conceptual validity of the tactical helicopter in that they affirm and reinforce, over time and space, the feasibility of the attack helicopter in an antitank role in a mid-intensity conflict scenario:

1. The Carmonette Air-Mounted Antitank System Effectiveness

war games study conducted in 1962 in support of the U.S. Army Tactical Requirements Board (Howze Board).

2. The Joint Attack Helicopter Instrumented Evaluation conducted in 1972, Headquarters, U.S. Army Europe and Seventh Army (Ansbach Test).

3. The Tactical Helicopter Employment Study completed in 1973 by the BDM Services Company, Monterey, California for the Combined Arms Combat Development Command (THES Study).

4. After action analyses of the 1971 Lamson 719 combat operation.

CARMONETTE

Background

CARMONETTE was a computer simulation of ground combat developed by the Research Analysis Corporation (RAC). Although the rules remained constant, the equipment studied, the location of the battlefield, and the tactics played underwent radical changes from play to play. The ground combat employed in the simulation was a battle called ARM IV. The battle was a meeting engagement of two company sized combined arms teams. The tactical situation was built upon a Red and Blue force. The Red force was composed of a tank company reinforced by a platoon of infantry and mortars. Its mission was to seize a road junction in order to permit the subsequent passage of a larger Red organization. The Blue force consisted of an infantry company minus, supported by a tank platoon. Its mission was also to seize the same road junction.[1]

Although CARMONETTE was not designed with aircraft in mind, both the model and battle situation exhibited potential application

for the investigation of the helicopter as an effective ground combat weapons system. As a result, four modifications of ARM IV were made to assist the Howze Board in determining the extent to which armed helicopters could function in a ground tactical role. These modified battles were named ARM VIII, IX, X, and XI.[2] Of these four tests, ARM IX and X are of particular relevance to this study.

ARM IX

The purpose of ARM IX was to measure the effectiveness of TOW-equipped helicopters compared to tanks in a tactical situation.[3] ARM IX was identical with ARM IV in force structure with the following exceptions:

1. The Blue force was given four HU-1B helicopters armed with TOW antitank missiles in place of the five M-60 tanks.

2. The Red force was given two ZSU-2 Twin 57mm (SP) antiaircraft guns in lieu of the two jeep-mounted 107mm recoilless guns.[4]

Additionally, the tactical scenario was altered to have the Red force accelerate its attack by attempting an armored thrust through the Blue force. The battle was played twenty times. The comparative results between ARM IV and ARM IX, in terms of losses to each side, are summarized in the tables below:

TABLE 2

Average Red Losses Per Play[5]

	ARM IV	ARM IX
Tanks killed by tanks	2.65	---
Tanks killed by TOW (Heli)	---	2.35
ZSU-2 killed by TOW (Heli)	---	0.45
Total tank and ZSU-2 losses	2.65	2.80

Average Blue Losses Per Play

	ARM IV	ARM IX
Tanks killed by tanks	2.50	---
Tanks killed by 107mm AT guns	0.50	---
Helicopters killed by ZSU-2 SPs	---	2.25
Total tank and heli losses	3.00	2.25

The above statistical summary of losses shows that the TOW-equipped helicopter force is comparable to the Blue tank platoon in antitank capability. On the other hand, the helicopter losses for Blue were comparable to its tank losses in ARM IV. The important conclusion that can be drawn from the ARM IX simulation is that the TOW-equipped helicopter weapons system proved as approximately effec-

tive in terms of destructive capability and survivability as the M-60 tank platoon.[6]

ARM X

The principal objective of ARM X was to investigate quantitatively the tactical advantage, if any, derived from employing two Blue helicopters initially forward of the Blue ground force.[7] The force structure for ARM X was primarily identical with ARM VIII, which differed from ARM IV in two respects. Added to the Blue force were two HU-1B helicopters armed with SS-11 antitank missiles. The Red force was only given one ZSU-2 Twin 57mm (SP) antiaircraft gun. The tactical situation portrayed in ARM X initially required the Blue helicopters to be forward of the Blue force in a reconnaissance and target detection role. As the Red force advanced, the Blue helicopters had two functions. First they had to transmit information relative to the Red force back to the Blue commander. Secondly, they were instructed to open fire on the Red armored vehicles to delay their advance and then to rapidly withdraw to preplanned positions in support of the Blue force.[8] The battle was played twenty times with the results expressed in the comparative summaries of ARM VIII and ARM X:

TABLE 3

Average Red Losses Per Play[9]

	ARM VIII	ARM X
Tank losses to tanks	2.40	4.15
Tank losses to SS-11 (Heli)	0.55	0.45
ZSU-2 losses to SS-11 (Heli)	0.15	0.15
Total tank and ZSU-2 losses	3.10	4.75

Average Blue Losses Per Play

	ARM VIII	ARM X
Tank losses to tanks	3.35	1.75
Tank losses to AT weapons	0.65	0.85
Helicopters killed by ZSU-2	0.85	0.75
Total tank and heli losses	4.85	3.35

The results of the two battles reveal that negligible difference existed between them insofar as helicopter vulnerability and fire effectiveness were concerned. The statistics do reveal a striking difference in the effectiveness and survivability of the Blue tanks; the Red force incurred 50% more vehicle losses and the Blue force

suffered 35% fewer tank losses.[10] This significant tactical success achieved by the Blue tank forces appears to have been directly related to the time and information advantage afforded by the helicopter in a "shoot and scoot" role forward of the line of contact.

In summary, the significant contribution of the simulated battles of the early CARMONETTE model established two important general constants. First, the organizational and operational concepts related to tactical helicopter employment were valid. Secondly, a helicopter armed with antitank guided missiles can not only destroy tanks but can survive against them. More importantly, the simulation model demonstrated that the helicopter, operating as an integral part of the combined arms team in a target detection and attack role, greatly enhanced the overall success of the total force engaged in ground combat against an armored force.

ANSBACH TEST

Background

The Joint Attack Helicopter Instrumented Evaluation, commonly referred to as the Ansbach Test, was a combined venture of the Federal Republic of Germany, the Canadian Forces, Europe, and the United States Army, Europe. The purpose of the Evaluation's trials in Phase IV of the test was to determine the effectiveness of attack helicopter teams executing antitank missions against aggressor forces in a variety of terrain situations typical to Central Europe.[11] Tanks, air defense weapons, and helicopters were equipped with laser direct fire simulators to provide real-time casualty assessment and automatic casualty identification. The four weapons systems simulated

on a real-time basis were:

1. The main tank guns of the friendly (M-60) and the aggressor (German Leopard) tanks.

2. The 12.7mm antiaircraft machine gun on aggressor tanks.

3. The ZSU-23-4 antiaircraft weapons system represented by the Vulcan.

4. An air-to-ground antiarmor missile having characteristics similar to the TOW weapons system.[12]

The tactical situations subjected to evaluation were friendly forces delay, friendly forces defend, and aggressor breakthrough of friendly lines.[13] In addition to varying the tactical situation, the mix of scout and attack helicopters was varied and evaluated accordingly. The first mix (2/1) was composed of two scout helicopters (OH-58A) and one antiarmor helicopter (TOW Cobra). The second mix (0/2) consisted of no scout helicopters and two antiarmor helicopters.[13]

Conduct of Experiment

Both sides were permitted extensive latitude and enjoyed virtually complete freedom in utilizing the terrain and tactical situation to their best advantage.[14] However, several factors were held constant throughout the evaluation. Helicopter crews flew nap-of-the-earth and attempted to attain the maximum standoff range of 3000 meters wherever possible. The size of the aggressor force was also held constant, as well as the number of instrumented tracked vehicles--three tanks and one simulated ZSU-23-4 (Vulcan).[15]

The results of the trial runs are summarized as follows:

Table 4

SUMMARY OF INSTRUMENTED EVALUATION CASUALTIES[16]

2/1 MIX

PERFORMANCE MEASURE	DEFENSE	DELAY	BREAKTH	TOTAL
Aggressor Tracked Vehicles Killed	12	19	36	67
Attack Helicopters Killed	2	0	0	2
Scout Helicopters Killed	1	1	2	4
Aggressor Tracks Killed Per Attack Helicopter Killed	6.0	--	--	33.5
Aggressor Tracks Killed Per Total Helicopters Killed	4.0	19.0	18.0	11.2

0/2 MIX

PERFORMANCE MEASURE	DEFENSE	DELAY	BREAKTH	TOTAL
Aggressor Tracked Vehicles Killed	33	21	73	127
Attack Helicopters Killed	1	2	6	9
Scout Helicopters Killed	--	--	--	--
Aggressor Tracks Killed Per Attack Helicopters Killed	33.0	10.5	12.2	14.1

The results, however, bear some qualification. During this phase of the Ansbach Test, the aggressor force did not employ and, as such, lacked the tactical advantage afforded by reconnaissance, suppressive fire, and close air support. Compounded to this disadvantage was the fact that the tactics of the aggressor force substituted speed of movement for security. Consequently, the opposing attack helicopters were able to engage the advancing aggressor tanks by surprise from a series of favorable ambush positions, without being exposed to enemy shell fire or other actions. The inherent bias of this phase was acknowledged by the noted authority on armored fighting vehicles, Richard M. Ogorkiewicz:

> This will undoubtedly occur on some occasions but to assess the effectiveness of antitank weapons on the basis of such favorable circumstances is unrealistic, to say the least...Had tanks been used in similar circumstances they too could have scored large numbers of hostile tank kills. 17

Nonetheless, many observations and conclusions can be made about the casualty data indicated in Table four. Foremost, it tends to reinforce the findings and conclusions of the CARMONETTE simulation, conducted a decade earlier, that the helicopter is an effective weapons system in a ground combat role against armored forces.

Secondly, the Ansbach Test affirmed the statistical inference of the CARMONETTE simulation that the employment of helicopters in a target detection role would significantly enhance the effectiveness and survivability of antiarmor forces. This affirmation was contained in the 2/1 helicopter mix. As a result of the scout helicopters performing reconnaissance and detection missions, the attack helicopter gained a significant tactical leverage from the information and time

advantage afforded. Thus, one of the major conclusions of the preliminary report of the Ansbach Test decreed that:

> The inclusion of scout helicopters in the antiarmor team is essential and noticeably enhances the survivability of the missile firing aircraft...Antiarmor helicopter teams designed for the European environment, therefore, should contain scout helicopters... 18

Third, the CARMONETTE simulation acknowledged that the helicopter acquired an advantage through the employment of the pop-up and nap-of-the-earth maneuvers. The ability for this tactical concept to stand the test of time was confirmed by two other major conclusions in the preliminary report of the Ansbach Test:

> Pilots effectively employed nap-of-the-earth flight techniques to conceal their presence and, when they were acquired, usually presented fleeting targets. 19

and

> To a large extent the favorable performance observed throughout the Instrumented Evaluation can be attributed to the ability helicopter crews demonstrated in employing hovering fire from well-concealed positions at stand-off ranges of engagement. Under these conditions the aggressor elements had great difficulty in acquiring and placing effective fire on antiarmor helicopters. 20

Although the final findings and conclusions of the entire evaluation aren't available for analysis, the importance of this study and the CARMONETTE simulation resides in the consistency of their respective findings. Despite a time difference of a decade and the employment of different research methodologies, the operational concepts originally validated in the earlier CARMONETTE simulation have been reconfirmed and reinforced by the Ansbach Test.

THES STUDY

The Tactical Helicopter Employment Study (THES), as illustrated

in Figure one, was a bibliographic data search and analysis of the myriad of diverse studies, tests, reports, and field experiments concerning the tactical aspects of attack, assault and scout helicopter operations for all intensity levels of warfare. The purpose of this endeavor, which particularly focused on the tactical employment of the attack helicopter, was to compile a single reference source or information base to assist Army planners in identifying fruitful directions for future helicopter programs.[21]

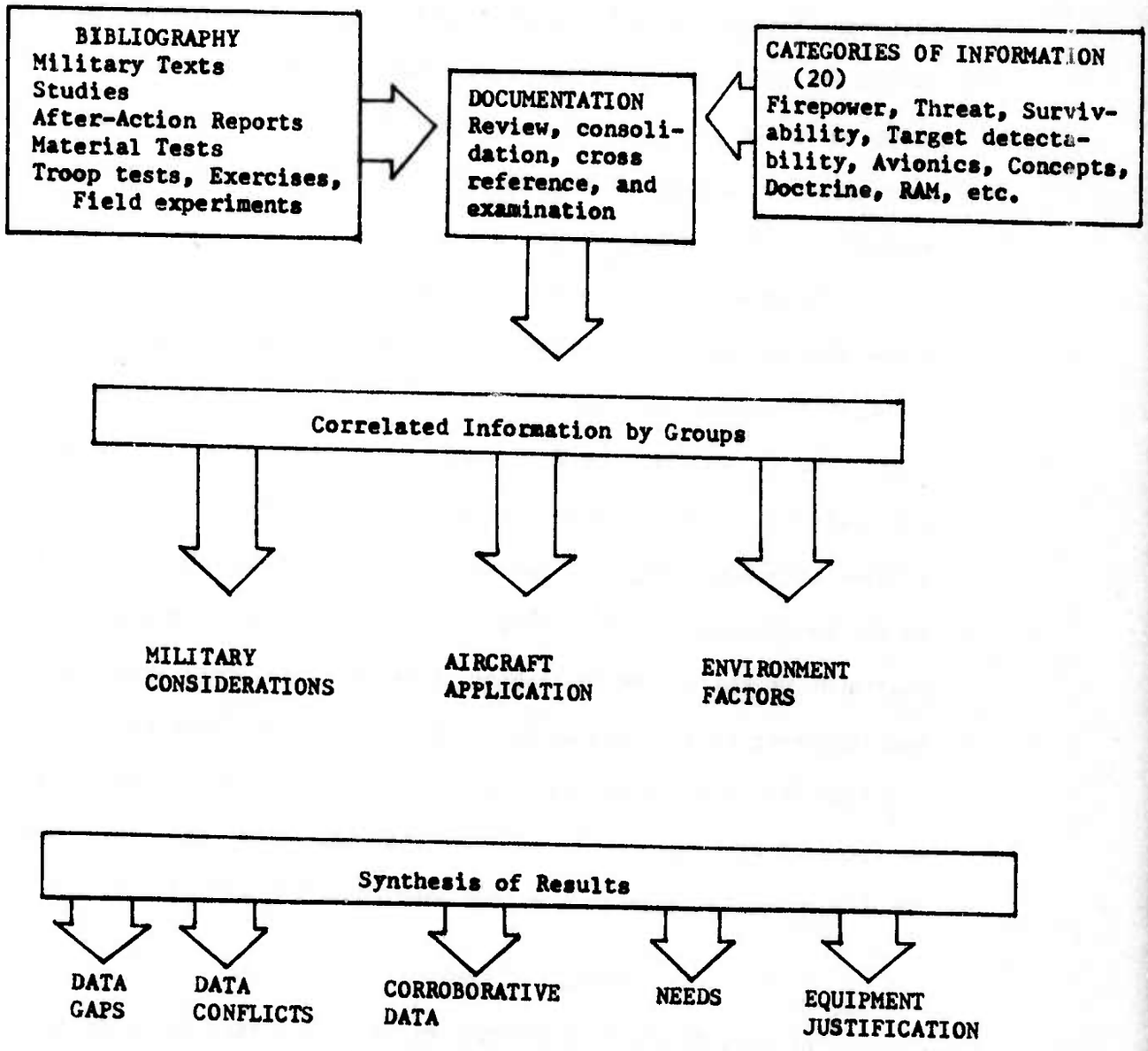


Figure 1

THES Research Design[22]

Primarily, several conclusions resulted from the study's data search and analysis. The first determined that the multitude of previously conducted field tests and operations generally confirmed the promulgated concepts related to helicopter employment.[23] The second conclusion acknowledged that the doctrinal statements pertinent to tactical helicopter utilization, employment, and mission assignment appear to be correct, well established, and generally accepted by the military community at large.[24] Lastly, the study proclaimed the dictum that the attack helicopter can be used as a primary armor-defeating weapons system.[25]

In summary, the previously discussed studies represented three diverse research methodologies. The CARMONETTE model utilized a computer simulation. The Ansbach Test was a series of instrumented field trials. Lastly, the THES study was a bibliographic data search and analysis. Despite their divergent methodologies, all three studies attained a point of commonality. This commonality resided in the consistency of their findings that the general concepts pertinent to the attack helicopter in an antiarmor role have remained constant over time. This consistency over time and mode certainly counters the findings of the HELL TANK test conducted by the British Ministry of Defense, which concluded that the attack helicopter was totally non-survivable on a modern sophisticated battlefield.

OPERATION LAMSON 719

As most military men firmly believe, the true test, in fact the only test, for assessing the actual rather than the hypothetical effectiveness of a weapons system is the test of combat itself.

Therefore, after action accounts of Operation Lamson 719 have been selected for two reasons. First, Lamson 719 demonstrated that the attack helicopter could survive in an intense air defense environment. Secondly, it demonstrated that the attack helicopter could survive battlefield engagements with tanks, as well as kill them. In this regard, Colonel Joseph H. Masterson, in a U.S. Army War College monograph, firmly declared:

> Most opponents of the armed attack helicopter will state that it cannot survive on a battlefield against tanks or in a mid-intensity combat environment. It already has. 26.

Operation Lamson 719, conducted from 8 February to 9 April 1971, was a cross-border operation into Laos. Its purpose was to reduce the North Vietnamese ability for waging war in South Vietnam by interdicting their supply and infiltration routes, and destroying their logistical facilities and supplies in southern Laos.[27] Although this was a combined United States and South Vietnamese operation, American combat personnel were prohibited from fighting on the ground in Laos.[28] Thus, American involvement was primarily restricted to the air. In response, the North Vietnamese had skillfully deployed an extensive, well integrated, highly mobile air defense system consisting of 12.7mm, 23mm, 37mm, and 57mm weapons throughout the entire operational area.[29] As the Army Vice Chief of Staff, General Bruce Palmer, Jr. remarked:

> Everything was against them, weather and terrain favored the enemy...This was the most hostile air environment that Army Aviation has ever operated in. They [enemy] had everything...Certainly, it was what some people call "mid-intensity." 30

Therefore, with the exception of enemy tactical aircraft, the air defense environment in Laos was as hostile and sophisticated as most

of the mid-intensity conflict scenarios throughout the world that possess the potential for the employment of United States military forces.[31]

Nonetheless, the fundamental concepts of tactical helicopter employment affirmed in the previously discussed research studies appeared to be validated in the test of combat. Major General Sidney B. Berry, Jr., then Assistant Division Commander (Operations) of the 101st Airborne Division (Airmobile), and intimately involved with helicopter operations in Laos, made several comments concerning Lamson 719:

> ...Our experience in conducting airmobile operations in support of Lamson 719 confirms the soundness of the concepts and principles of airmobility developed by the U.S. Army. We have, of course, modified and adapted specific tactics and techniques to cope with the operational environment. But airmobility principles and concepts have proven sound and valid...The helicopter and its crew have proven remarkably hardy and survivable in the mid-intensity conflict and hostile air defense environment of Lamson 719. 32

Further credence to the soundness of the basic airmobility concepts is established by Lieutenant General John J. Tolson, who has been involved with the airmobile concept since 1939. In his monograph on airmobility he declared this basic fact of Lamson 719:

> It would never have been undertaken, much less successfully completed without the support of thousands of helicopter sorties. AND FOR EVERY THOUSAND SORTIES THE LOSS RATE WAS ONLY ONE QUARTER OF ONE PERCENT. 33
> [Emphasis: LTG Tolson]

A better endorsement came from the Army aviators themselves. After Lamson 719, they expressed the firm belief that "if we could pull this off under these conditions, we can do it anywhere in the world."[34]

In addition to combat testing the helicopter in a mid-inten-

sity environment, Lamson 719 also provided the first test of attack helicopters against tanks. The North Vietnamese responded to the Laos invasion by heavily reinforcing their forces and committing a variety of weapons including tanks. The employment of tanks culminated with the North Vietnamese conducting a classic armor attack against Fire Base 31.[35] Thus, unexpectedly, the tactical mission of seeking out and engaging enemy armor was thrust upon the armed attack helicopters.

The intensity, magnitude, and flavor of this antiarmor mission is graphically illustrated in the following account written by Lieutenant Colonel Robert F. Molinelli, who commanded the armed attack helicopters in this mission:

> The majority of the enemy tanks seen were T-34's mounting either an 85mm or 100mm main gun, a 12.7mm and a 7.62mm turret machine gun. The remainder were PT 76's mounting what was believed to be a 76mm main gun and a 12.7mm AA gun and a 7.62mm turret machine gun.
>
> We reported a total of forty-seven tank engagements. In all cases the tank used its 12.7mm gun in defense. In some cases the tank used its 76mm or 85mm gun in defense. Most tanks were protected by troops and other weapons. WE DID NOT LOSE AN AIRCRAFT OR CREW MEMBER FROM A HELICOPTER--TANK ENCOUNTER [Emphasis added]...We reported...six tanks destroyed, nineteen immobilized and eight damaged by helicopter. 36

From the foregoing account, it is apparent that the present day TOW Cobra possesses the potential to defeat armor on the battlefield. As noted by General Berry, the remarkable success enjoyed during Lamson 719 was accomplished by an armed attack helicopter that was not even developed as an antiarmor weapons system:

> ...We need now tank-defeating armed helicopters... Had we entered Lamson 719 with a helicopter armed with an accurate, lethal, relatively long-range antitank weapon, we would have destroyed many more NVA tanks...I am

> absolutely convinced that the U.S. Army must field immediately an armed helicopter with an effective tank-killing capability. 37

A QUESTION OF PRIMACY

The findings of these and other research studies, experimental tests, and combat results, have produced in military writings, a gradual but clearly discernible advancement of the attack helicopter as the optimum tank killer on the battlefield.

In 1970, an article in Armor magazine alluded that the attack helicopter was a potential challenger to the long-established maxim that: THE BEST DEFENSE AGAINST A TANK IS ANOTHER TANK. In expressing this challenge, the author acknowledged the antiarmor capability of the helicopter in his statement that, "Since its inception, armor has had the primary mission of antiarmor and should retain that responsibility whether using a tank or an attack helicopter."[38] Several years later, this position was advanced even further by the authoritative THES study. This important study declared in its introduction that, "It is generally agreed that attack helicopters will be in the primary role of an antiarmor system."[39] Approximately one year later, additional fuel was added to the tank-attack helicopter debate by Major General William J. Maddox, Commander, U.S. Army Aviation Center. In an article for Aviation Digest, General Maddox strongly implied that the helicopter should be developed as the principal armor-defeating weapons system:

> ...Most people think in terms of two attack helicopters pitted against an enemy target, perhaps with the help of aerial scouts. Instead, we must think of employing attack helicopters as we employ tanks--in mass--by platoon, company, and battalion. 40

Despite the growing advocacy of the attack helicopter as the primary armor-defeating weapons system, a review of the literature indicates that this route is still fraught with a significant degree of skepticism, doubt, and uncertainty. The question of whether or not the attack helicopter should even be employed in an antitank role continues to be disputed by every developed country with a standing army. Even the United States Marine Corps, to date, rejects the concept of the attack helicopter in an antitank role, and only envisions attack helicopter/tank engagements when survival is threatened.[41]

Many professional military writings are still replete with arguments on behalf of the tank as the principal tank killer on the battlefield. Illustrative of this view is an article by Major N.A. Shackleton, Canadian Armed Forces. In addressing the effectiveness of modern antitank weapons, he argues that "...the foremost antitank weapon is probably another tank sited in the defense...What we really need is more of them."[42] Additionally, an article assessing the lessons of the 1973 October Mid-East War concluded that "...armor is battlefield-decisive so long as it is used wisely with proper air, artillery and infantry support."[43]

Proponents for the tank can also find comfort in the Main Battle Tank Task Force Support Study which examined the relationship between the main battle tank and attack helicopter. This 1972 study, in analyzing the numerical impact of Soviet assault forces on the U.S. Army's concept of defense based upon extended frontages concluded that:

> Infantry units cannot continue to hold ground against echeloned attacks unless they receive additional combat

> power. Because of their armor protection, mobility, and firepower, tank units provide the best form of additional combat power. 44

However, the most significant factor that exacerbates and impedes any possible resolution of the tank-attack helicopter controversy resides in the official, but dated (1966), publications of U.S. Army doctrine. Field Manual (FM) 17-1 decrees that "The tank is the primary armor-defeating weapon of armored formations."[45] FM 17-15 similarly establishes the primacy of the tank as the principal antitank weapon:

> The tank is the primary antitank weapon in the armored infantry and mechanized divisions. Other antitank weapons systems...are also employed, but they do not possess the tank characteristics of mobility and armor-protected firepower. The tank is the principal means for destroying enemy armor. 46

SUMMARY

In reviewing the literature central to the present controversy, it is apparent that the U.S. Army is presently stalled at the doctrinaire crossroads. This lack of positive direction appears to be inextricably bound with the unresolved question of whether or not the TOW Cobra attack helicopter represents the beginning of the end for the tank on the battlefield. Therefore, this study seeks to address the question as to whether or not the TOW Cobra or the present U.S. Army main battle tank, the M60A1, should be designated the primary building block for the modern antitank defense required by the mid-intensity European conflict scenario.

CHAPTER II

FOOTNOTES

1. H.E. Adams, J.A. Bruner, R.E. Forrester, D.M. Lester, "Carmonette Air-Mounted Antitank System Effectiveness," Research Analysis Corporation, (Maryland, July 1962), p. M3-5.
2. Ibid., p. M3-1.
3. Ibid., p. M3-14.
4. Ibid.
5. Ibid., p. M3-17.
6. Ibid., p. M3-18.
7. Ibid., p. M3-19.
8. Ibid.
9. Ibid., p. M3-20.
10. Ibid., p. M3-21.
11. Headquarters Joint Evaluation Group, "Joint Attack Helicopter Instrumented Evaluation - Preliminary USAREUR Report - Phase IV," (June 1972), p. 1.
12. Ibid., p. 2.
13. Ibid., p. 7.
14. Ibid.
15. Ibid., p. 9.
16. Ibid., p. 12.
17. Richard M. Ogorkiewicz, "Antitank Weapons," Armor, May-June 1973, p. 25.
18. Headquarters, op. cit., p. 20.
19. Ibid.
20. Ibid.
21. BDM Services Company, Tactical Helicopter Employment Study (Thes) Vol. I (Monterey, California, November 1973), p. 1-1.
22. Ibid., p. 2-3.

23. Ibid., p. 4-2.

24. BDM Services Company, Tactical Helicopter Employment Study (THES) Vol. II (Monterey, California, November 1973), p. B-24.

25. Ibid., p. A-6.

26. Colonel Joseph H. Masterson, "The Aerial Vehicle: A Technological Threat to Armored Warfare," United States War College Research Paper, 28 February 1972, p. 11.

27. LTG John J. Tolson, Airmobility 1961-1971, Vietnam Studies, (Washington, D.C.: Department of the Army, 1973), p. 237.

28. Ibid., p. 236.

29. Ibid., p. 245.

30. GEN Bruce Palmer, Jr., "Army Aviator of the Year," Army Aviation, 31 December 1971, p. 22.

31. Tolson, op. cit., p. 245.

32. Ibid., pp. 250-251.

33. Ibid., p. 252.

34. Ibid.

35. Ibid., p. 241.

36. Masterson, op. cit., p. 12.

37. Tolson, op. cit., p. 250.

38. LTC Carl M. Putnam, "Proponency of Aerial Fighting Vehicles," Armor, May-June 1970, pp. 7-10.

39. THES, op. cit., Vol. I, p. xiii.

40. MG William J. Maddox, "Where We Are - Where We Are Going," Aviation Digest, November 1974, p. 21.

41. CPT George L. Youngblood, "The Attack Helicopter Vs Armor: A Study of Tactics and Techniques," CGSC Student Paper, April 1974, p. 4.

42. Major N.A. Shackleton, Lord Strathcona's Horse (Royal Canadians), "Will the Tank Go the Way of the Horse?," Armor, September-October 1968, pp. 4, 8.

43. Kenneth S. Brower, "Armor in the October War," Armor, May-June 1974, p. 15.

44. U.S. Army Combat Development Command, "MBTTF Support Study: An Examination of MBT/AAH Relationship," July 1972, p. E-8.

45. FM 17-1, Armor Operations, (Headquarters, Department of the Army, October 1960), p. 6.

46. FM 17-15, Tank Units Platoon, Company and Battalion, (Headquarters, Department of the Army, March 1966), p. 65.

CHAPTER III

METHODOLOGY OR PROCEDURES

DESCRIPTION OF RESEARCH METHODOLOGY

Technically defined, a research methodology constitutes nothing more than the orderly arrangement of those investigative methods or procedures which facilitate the application of logic and reason to scientific and intellectual inquiry.[1] Within this context, the functional objectives of a research approach are twofold. First, it is oriented toward describing and analyzing the products of the inquiry and not the methodological process. Secondly, it is aimed at stimulating the requisite degree of consciousness to produce a reflective understanding of the research means; for methodology, as acknowledged by Max Weber:

> ...can only bring us reflective understanding of the means...by raising them to the level of explicit consciousness; it is no more the precondition of fruitful intellectual work than the knowledge of anatomy is the precondition for correct walking. [2]

Thus, for the purpose of this study, the adopted research methodology is not concerned with attaining a complete awareness of all the complexities inherent to the process of inquiry. Instead, its primary purpose is to serve as an investigative tool to help unblock the roads of inquiry.[3]

RESEARCH DESIGN

Dependent Variable

Since cost has become as important as performance, operational

effectiveness has become the critical determinant in systems evaluation. Pursuant to this factor, the methodological approach of this study is directed towards the construction of a research design that establishes operational effectiveness as the dependent variable. Such a design facilitates a comparative analysis of the capabilities of each system to counter the projected threat, and provides the researcher with an analytical tool for assessing whether or not the main battle tank and attack helicopter are competitive or compatible antiarmor weapons systems.

Independent Variables

In regard to operational effectiveness, General Hamilton H. Howze stated that "Ultimately...even risk must be measured against effectiveness itself."[4] His statement suggests that the operational effectiveness of any weapons system is a product of its performance parameters in relation to systems design and actual combat. Consequently, the dependent variable of operational effectiveness must be assessed in terms of combat performance as well as vehicle design performance. Since design performance and combat performance cannot be totally controlled, regulated, or manipulated, they function as independent variables and directly influence the coefficient of effectiveness for each weapons system as a whole.

Measures of Effectiveness

In order to operationalize the independent variables of systems design and combat performance, it is necessary to first identify a set of performance factors as measures of effectiveness that are common to both systems. These measures of effectiveness

facilitate the comparative measurement of the main battle tank and attack helicopter by establishing a criterion of order among the multiplicity of performance factors associated with the two weapons system. This criterion of measurement is a device for standardization that assures the researcher of equivalences among systems of diverse design and operational capabilities. Furthermore, this criterion delimits the scope of analysis by providing a parsimonious number of performance factors for comparative analysis and measurement. Credence for this approach is contained in a Ford Motor Company study which concerned itself with the application of trade-off methods for armored vehicle design evaluation:

> It is desirable for the purpose of a trade-off analysis to employ the smallest number of performance variables which will adequately define the vehicle system and its capabilities...it is particularly important to avoid unnecessary variables which might only confuse the application of the research technique. 5

Classificatory Variables

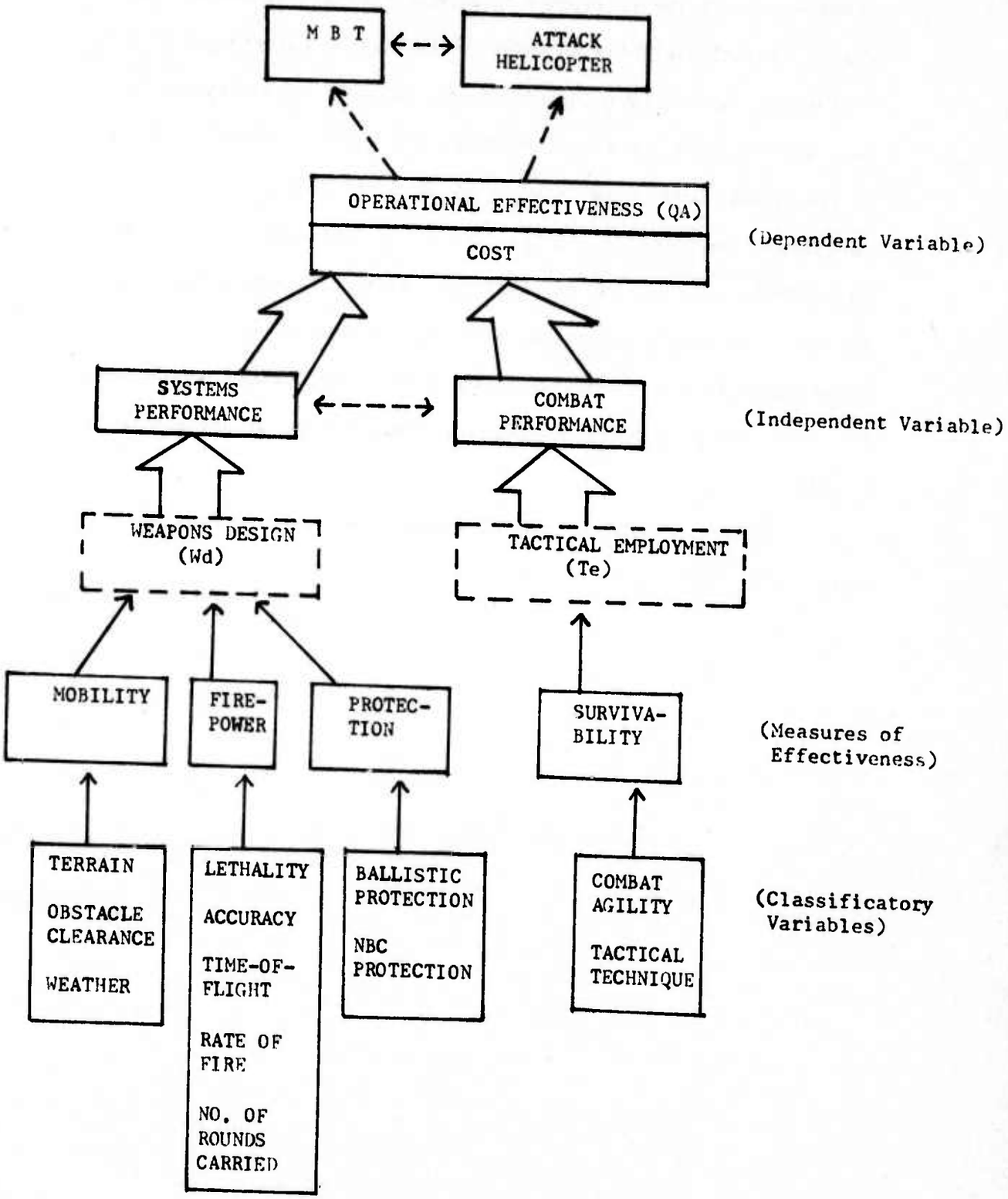
The measures of effectiveness relative to systems design performance are identified as mobility, firepower, and protection.[6] Each of these measures of effectiveness are a product of design and are governed by certain classificatory variables. Mobility includes such classificatory variables as terrain, obstacle clearance, and weather. Firepower variables include lethality, accuracy, time of flight, rate of fire, and number of rounds carried. Lastly, the protection variables consist of ballistic protection and nuclear-biological-chemical (NBC) protection.

A key measure of effectiveness common to the combat performance of the main battle tank and attack helicopter is survivability.

Since survivability is related to combat risk and exposure, the classificatory variables of survivability are a function of tactical employment and are twofold. The first variable is combat agility. Relative to survivability, combat agility constitutes the ability of the combat vehicle to avoid enemy fire and obstacles through mobility. The second variable, tactical technique, maximizes the capabilities of the combat vehicle in relation to the enemy's capabilities for target detection, acquisition, and destruction. Thus, in relation to combat survivability and mission accomplishment these two variables can afford significant advantages or disadvantages for success.

The description of the aforementioned research design is graphically depicted in Figure two.

OPERATIONAL EFFECTIVENESS ANALYSIS MODEL



RESTATEMENT OF CONCEPTUAL HYPOTHESES

As depicted, the focus of the adopted research design is not the methodological process but the products of the inquiry--the main battle tank and the attack helicopter. As such, the research design is concerned with determining which courses of action would be most acceptable within the confines of the dependent variable (operational effectiveness).

1. Continued development of the main battle tank as the primary armor-defeating weapons system.

2. Adoption of the attack helicopter as the primary armor-defeating weapons system.

3. The integration of the main battle tank and attack helicopter into a dual but complementary armor-defeating weapons system.

To make this determination, the conceptual hypotheses from the problem chapter must be restated in operationalized form. The restated operational hypotheses are twofold:

> IS THE M60A1 MAIN BATTLE TANK OR THE TOW COBRA ATTACK HELICOPTER THE MOST EFFECTIVE ANTIARMOR WEAPONS SYSTEM IN TERMS OF SYSTEMS PERFORMANCE.
>
> and
>
> RELATIVE TO THE EUROPEAN THREAT, CAN THE TOW COBRA ATTACK HELICOPTER COMPENSATE FOR NATO'S QUANTITATIVE INFERIORITY OF MAIN BATTLE TANKS BY OPTIMIZING ITS CAPABILITIES THROUGH TACTICAL EMPLOYMENT.

These operational hypotheses will be tested by the selected measures of effectiveness, relative to systems performance and

combat performance, that are common to both weapons systems. Then, through a comparative analysis of these measures of effectiveness, it will be demonstrated that the M60A1 is a better or more effective antiarmor weapons system than the TOW Cobra; or that neither the M60A1 or TOW Cobra is a singularly better antiarmor weapons system in terms of operational effectiveness.

METHODOLOGICAL ASSUMPTIONS

In regard to the testing of the aforementioned hypotheses three important assumptions must be made. These assumptions are as follows:

1. No technological breakthroughs will occur to increase the vulnerabilities or capabilities of the M60A1 main battle tank or TOW Cobra attack helicopter.

2. Antiarmor and air defense weapons systems organic to the threat ground forces will remain the primary threat to the M60A1 and TOW Cobra, respectively.

3. Technological advancements, pertinent to antiarmor and air defense weapons systems will progress at an arithmetic pace and not a geometric leap.

LIMITATIONS

For the purpose of delimitation, consideration has not been given to the effects of night operations and high performance tactical aircraft on the operational effectiveness of the main battle tank and attack helicopter. The imposition of this limitation is based upon the evidence that neither factor presently exercises any significant

influence on their vulnerabilities or capabilities.

Night Operations

In regard to night operations the influential THES study and the Special Working Party for Aircraft Survivability in the Battlefield Environment acknowledge that the fundamentals involved in night operations are the same as those in daylight operations. The only difference is technique. Night operations are conducted in the same manner as daylight operations except that they are characterized by more control measures, more detailed plans, slower movement, and thorough coordination between all elements.[7] This acknowledgement was affirmed by a simulation that evaluated the effectiveness of helicopter attacks under both day and night conditions. In both situations the helicopter attacks were conducted identically against a typical Soviet-type tank company on the approach march with the normal level of air defense. The result of these attacks revealed that the vehicle/helicopter loss ratio was the same for both daylight and night conditions.[8] In other tests relative to night engagement, data compiled from three Modern Army Selective Systems Test Evaluation and Review (MASSTER) tests disclosed that the range of target dectection with night optics is quite close to that attained with daylight optics. Furthermore, due to existing control equipment, both the tank and TOW are unable to engage targets over 1,000 meters under conditions of darkness.[9]

High Performance Tactical Aircraft

As indicated by a series of tests completed with Navy tactical aircraft in 1970, it was found that the susceptibility of the attack

helicopter to engagement by high performance tactical aircraft was relatively low.[10] Recent exercises also indicate that high performance tactical aircraft have a low probability of success in acquiring an attack helicopter in flight. In the majority of the tests, the attack helicopter crew was able to acquire the tactical aircraft first, permitting it the response time to avoid detection by landing or hovering close to the ground in areas that afforded a relative degree of concealment.[11] Furthermore, in dealing with the detectibility of the attack helicopter by tactical aircraft, tests were initiated in 1973 by the Combat Developments Command Experimental Command (CDCEC) to examine the potentiality of the attack helicopter to actively defend itself against high performance tactical aircraft. The findings of this evaluation established that the attack helicopter can be given an air-to-air capability against high performance tactical aircraft by arming it with the Redeye missile.[12] Thus, all of these tests not only affirm the evidence of the October 1973 Arab-Israeli war that the helicopter can survive on the modern battlefield, but also strengthens the reports of the Israeli Air Force that "helicopters can with great facility and ease evade jet fighters."[13]

With the coming of age of the air defense weapons systems organic to ground maneuver elements, the threat of high performance tactical aircraft to the main battle tank has been significantly degraded. For high performance tactical aircraft to be an efficient and effective killer of tanks, it should achieve a kill ratio of 12 tanks to one aircraft lost.[14] As demonstrated in the 1973 Arab-Israeli war, the air defense umbrella afforded by modern air defense systems can render high performance aircraft ineffective as a tank

killer in support of ground forces.[15]

SUMMARY

Exactness is not as important for scientific status as objectivity. Thus, as the aforementioned conceptual and operational hypotheses are tested, validated, or nullified, the goal of the researcher, as always, should be "How can he learn more than he knows now?" and "How can he become sure of what he already thinks he knows?"[16] In striving towards the attainment of this goal, clarity of purpose should replace the ambiguity of the present tank-attack helicopter debate. Furthermore, it is hoped that this goal, within the parameters of the adopted research design, will offer a conclusion as to what the tactical relationship of the main battle tank and attack helicopter should be on the mid-intensity battlefield.

CHAPTER III

FOOTNOTES

1. Jean L. McKechnie, ed., Webster's New Twentieth Century Dictionary, Unabridged, Second Edition, (New York: The Publishers Guild, Incorporated, 1961), p. 1134.

2. Abraham Kaplan, The Conduct of Inquiry (Scranton, Pennsylvania: Chandler Publishing Company, 1964), p. 24.

3. Ibid.

4. Henry A. Miley, Jr., "Cost is the Arbiter in Weapons Design," Army, October 1973, p. 73.

5. J.L. Putnam, F.W. Cleaver, J.M. Owen, "Application of Trade-off Methods to Armored Vehicle Design Evaluation," Publication No. S-2279, Ford Motor Company, Aeronutronic Division, 25 September 1963, p. 3-1.

6. Ibid., p. 1-1.

7. BDM Services Company, Tactical Helicopter Employment Study (THES) Vol. VII (Monterey, California, November 1973), p. I-S-24. and U.S. Army Aviation Center, Special Working Party for Aircraft Survivability in the Battlefield Environment (Ft. Rucher, Alabama, March 1974), p. 28.

8. Ibid., p. I-S-57.

9. BDM Services Company, op. cit., pp. I-S-207 and I-E-577.

10. Captain James P. Isenhower, Jr., "NOE-Survival Altitude," Infantry, November-December 1973, p. 16.

11. BDM Services Company, op. cit., p. I-E-593.

12. Isenhower, op. cit.

13. Ibid.

14. U.S. Command and General Staff College, Selected Readings in Tactics, RB 100-2 Vol I Cl, (Ft. Leavenworth, Kansas, 28 June 1974), p. 1-62.

15. Ibid.

16. Kaplan, op. cit., p. 173.

CHAPTER IV

FINDINGS (ANALYSIS AND EVALUATION)

HYPOTHESIS ONE: CAN THE DEFEAT OF MASS ARMORED FORCES BE INDEPENDENT OF FORCE RATIOS.

Today, a nearly infinite number of wargaming models and simulations pertaining to the analyses of combat exist. The most basic formulas of these models and war games are derived from Lanchester's square law. This law is generally accepted, among wargaming analysts, as being as elemental to an analysis of combat as Newton's laws are to an analysis of motion.[1] As a consequence, the Lanchester square law and its myriad computerized off-spring is the most fashionable and the most widely used tools for analyses.[2]

The essence of the Lanchester formulation is concerned with the rate of attrition in combat. The rate of attrition for opposing forces during a battle is described by two sets of simultaneous differential equations which are expressed as follows:

$$\frac{d\,x\,(t)}{d\,t} = Ky\ y\ (t)$$

$$\frac{d\,y\,(t)}{d\,t} = Kx\ x\ (t)$$

x(t) and y(t) equal the expected number of surviving force units for blue and red forces as a function of time after the engagement begins. Ky equals the constant rate at which a blue unit destroys red units, and Kx equals the constant rate at which a red unit destroys blue units. The constants are normally computed using manipulations of firepower

indices.[3]

An examination of these sets of equations indicates that if the opposing forces are quantitatively matched in the engagement, Ky and Kx will approach zero simultaneously until ultimately Ky = Kx = 0. Under this condition, the sets of equations can be reduced to $Ky^2 = Kx^2$. This equation represents the Lanchester square law.[4] Implicit in Lanchester's square law are several important suppositions:

1. The attrition rate for a force, regardless of its size, is a constant multiplied by the surviving strength of the opposing force.

2. The rate of attrition of opposing forces is directly proportional to the number of weapons employed.

3. Quantity is the determinant in deciding the outcome of combat in that it is represented as a square function.

4. The draw condition depicted for opposing forces is a function of the numerical equality or equivalences of fighting strengths.[5]

Relative to the European mid-intensity conflict scenario, the Lanchesterian model possesses relational importance for the question of defense against massive armored forces. This importance resides in its mathematical formulation that success or failure on the battlefield is a function of numerics or quantity. The potential for numerical imbalances to degrade the chances of tactical success on the battlefield has historical precedence in the German experiences of World War II. During the waning battles of the war, the German armored forces still possessed qualitatively superior tanks with a better main armament system than the United States tanks. Nonethe-

less, the United States was able to overcome this qualitative disadvantage simply by employing a larger number of inferior tanks.[6] In this historical case, quantity was a determining factor of success.

The tacit acceptance of the Lanchester square law and the lesson of the German experience is found today in the general concern of many professional soldiers over the numerical inferiority of NATO's ground combat elements vis a vis the Warsaw Pact ground forces. The degree of concern pertinent to this force imbalance and its potential for denigrating the chances of success on the European battlefield was addressed in a 1971 Command and General Staff College student monograph. This study analyzed and evaluated the combat power of the United States and its NATO allies to counter the armor threat of the Soviet-led Warsaw Pact armies. Based upon his findings, the author expressed the conscious concern and latent fears of many of his fellow officers in his conclusion that "...we [U.S. and NATO allies] do not have the combat power nor will have the combat power to meet a Soviet armor threat in Central Europe during the 1971-1980 time frame.[7]

At this juncture, it is apparent that there exists substantive, if not indisputable, mathematical models, historical evidence, and a professional perception that the quantity of forces and weapons systems will be a critical, if not conclusive, determinant of success on the European battlefield. In view of these considerations and the existing fiscal constraints which mitigate the argument for quantitative superiority or parity, the significance of this study's central hypothesis is clearly discernable -- "Can the defeat of massive armored forces be independent of force ratios?"

The evaluation of hypothesis one is operationalized by a comparative analysis of the Lanchester square law, which lends scientific or mathematical credence to the correlation of battlefield success and force ratio, with direct empirical plots of historical win-loss results. As illustrated, Figure three shows a comparison of the empirical variation of battle outcomes according to the popularly used theoretical square law type prediction.[8]

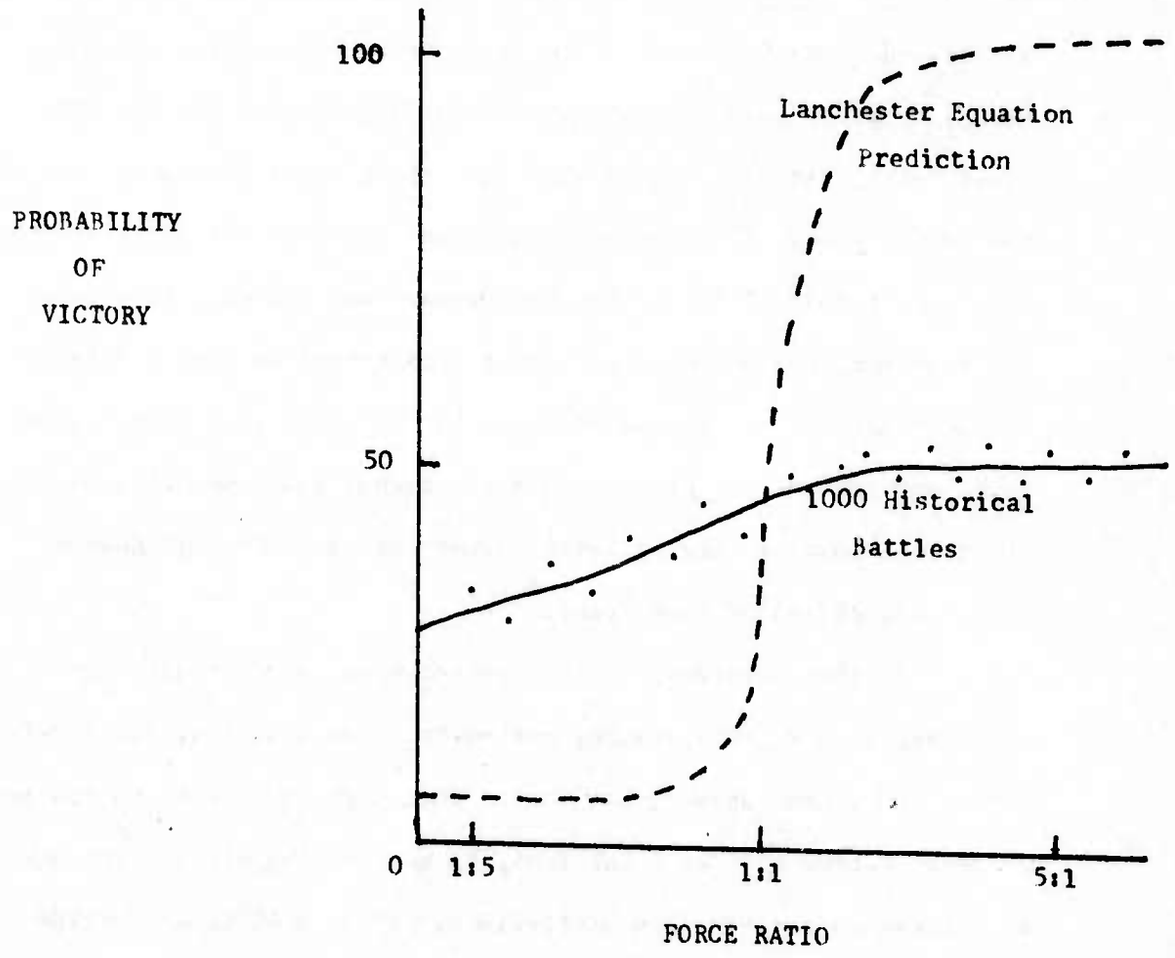


Figure 3

Historical Win-Loss Results[9]

It is interesting to note that the Lanchesterian prediction doesn't even approximate the empirical plots of historical battle outcomes. Even more interesting and revealing is the historical fact that even an overwhelming force ratio advantage of 5:1 guaranteed only slightly more than a fifty percent chance of success. Thus, the predictions of the Lanchesterian square law are not only inconsistent with actual battle outcomes but also tend to overstate the relationship of force ratio to battle success.[10]

Further analysis of historical data challenges the intuitive thinking of many professional soldiers as well as the Lanchester square law which assume that the rate of attrition per opposing force units is a constant dependent upon quantity. To the contrary, historical data consistently reveals that the more outnumbered a force is, the more favorable its exchange ratio. This historical evidence should not be construed to mean that increasing the inferiority of a force increases its chances for winning. It simply means that numerically inferior forces can extract an unfavorable enough exhange ratio to make victory uncertain for larger opposing forces.[11] This effect can be seen in Figure four which illustrates that doubling the superior force improves the inferior force's exchange ratio.[12]

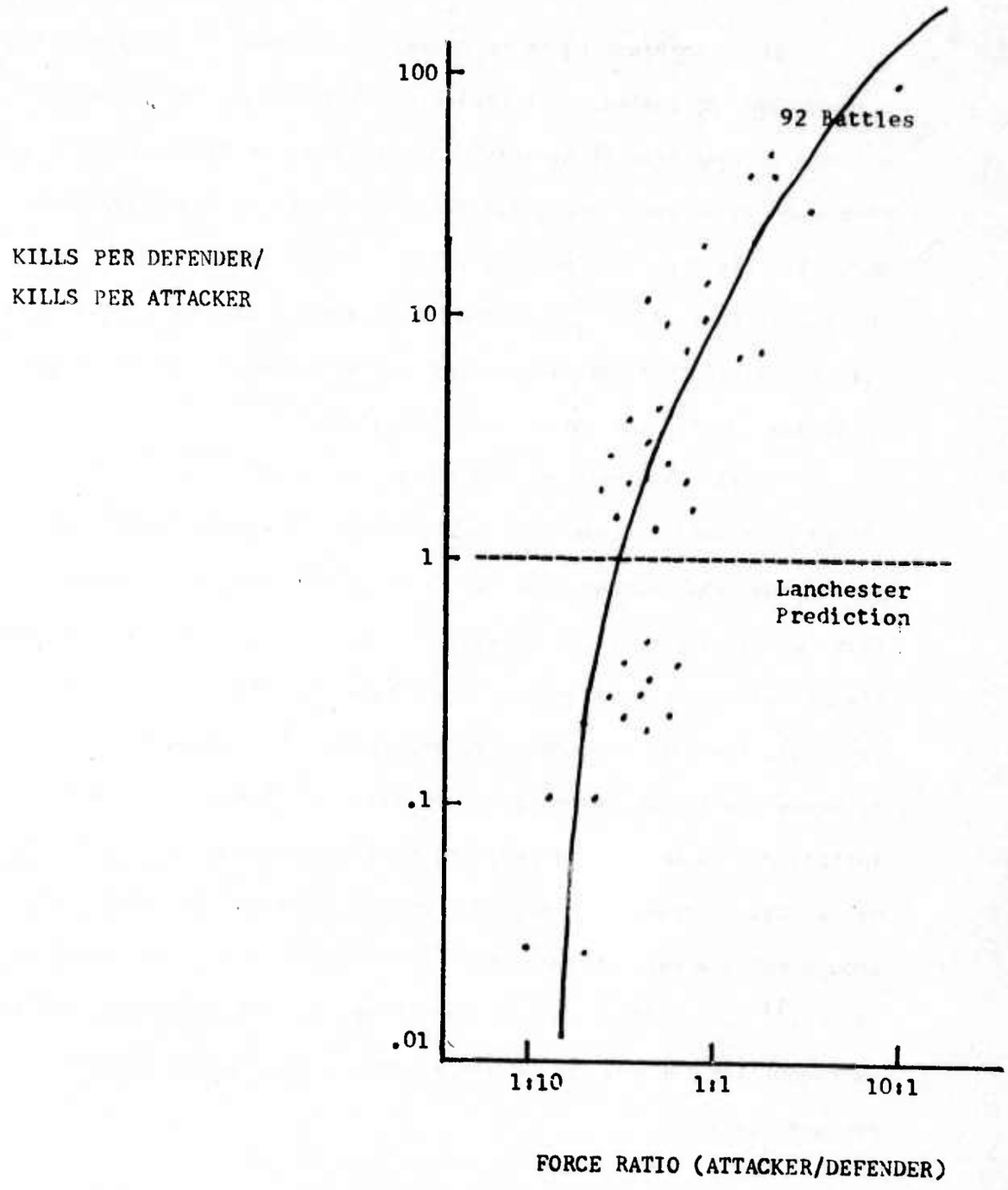


Figure 4

Historical Exchange Ratios[13]

In comparing the Lanchester square law with the historical data relative to actual win-loss outcomes, certain findings are revealed in relation to the hypothesis posited. First, the historical battle outcomes appear to be relatively insensitive to prevailing force ratios. Secondly, the available historical data indicates that the dominant aspect of combat capability is not necessarily sensitive nor dependent upon a superior force ratio as predicted by the Lanchesterian model. Nonetheless, these findings should not be used to arbitrarily invalidate the Lanchester model. Even the authors who conducted the study that argued against the tacit acceptance of the Lanchester model concluded: "...we resolve the argument between quality and quantity on the side of quantity--with reservations."[14] Suffice to say that the quantity of forces and weapons exert considerable influence on the battlefield. However, quantity is not the sole determinant of success as Lanchester's square law decrees. There exists in the present, as in the past, other important factors within our control that can significantly influence combat outcomes.[15] Thus, the findings related to this study's central hypothesis indicate that a successful antiarmor defense can, in fact, be independent of force ratios.

HYPOTHESIS TWO:
IN ORDER TO ATTAIN A FAVORABLE EXCHANGE RATIO, WITHIN EXISTING FUNDING CONSTRAINTS, THE U.S. ARMY SHOULD REPLACE THE MAIN BATTLE TANK WITH THE ATTACK HELICOPTER AS THE PRINCIPAL ARMOR DEFEATING SYSTEM.

In consideration of the findings pertinent to the central hypothesis of this study, it is apparent that a favorable exchange

ratio against a numerically superior force can be extracted--provided a qualitative advantage (QA) can be achieved. The attainment of this advantage is made possible by weapons design (Wd) and tactical employment capabilities (Te). Thus, reduced to mathematical formulation, the main battle tank and attack helicopter will be assessed in terms of Wd x Te = QA.

In order to test hypothesis two in terms of Wd, it must be restated in operational form to enable measurement and testing:

> IS THE M60A1 MAIN BATTLE TANK OR THE TOW COBRA ATTACK HELICOPTER THE MOST EFFECTIVE ANTIARMOR WEAPONS SYSTEM IN TERMS OF SYSTEM PERFORMANCE.

As stated in the methodology chapter, this sub-hypothesis can be tested best by identifying and selecting measures of effectiveness relative to the systems performance parameters of both the M60A1 and TOW Cobra. The measures of effectiveness selected for comparative analysis are mobility, firepower, and protection.

Mobility

In general, tactical mobility is concerned with the movement of combat vehicles to an engagement area. Specifically, tactical mobility is defined as the ability of the combat vehicle system to move quickly from point to point in the battle area in order to accomplish its tactical mission.[16] Undoubtedly many factors or variables affect mobility. For a comparative analysis, however, only those classificatory variables that reflect a significant difference between the M60A1 main battle tank and TOW Cobra attack helicopter should be considered.[17] Since the greatest disparity of

the two systems is speed of movement, the classificatory variables subjected to evaluation are those which impede the speed of movement. These variables are terrain, obstacle clearance, and weather.

M60A1. Due to the fact that many of the main battle tank studies only addressed mobility in terms of the M60 tank series, the performance parameters of the M60A1 are considered to be representative of those reported as the M60 tank series.

The maximum speed of the M60A1 is 30 miles per hour under ideal road conditions.[18] Although the speed of movement of the M60A1 is not directly affected by weather, its speed of movement is affected by difficulty of terrain. Therefore, under cross country conditions, which can be expected to be the norm in combat, the M60A1's optimum speed is reduced significantly. The reason for this degradation of cross country speed is the fact that the movement of the M60A1, like all tanks, is dependent upon the relationship between systems design and terrain.

The performance parameters that impact most upon cross country speed are the power train system and the physical tolerance of the crew. Two studies conducted by the Human Engineering Laboratories, Aberdeen Proving Grounds, demonstrated the suspension limitations of the M60 series tanks during cross country movement.

The first study, conducted in 1965, required that the M60 tank be driven at speeds of 8-24 miles per hour over two types of cross country courses. During the test runs, many suspension system difficulties occurred at speeds from 8-24 miles per hour with road wheel bearings and arms failing about every fourth run or approximately

every 7 miles.[19] The second study was conducted in 1972. In evaluating the performance of the M60 series tank over rough terrain, it also found that the M60 tank was particularly suspension limited. These studies also revealed that the cross country movement speed of the M60 series tank was degraded not only by the mechanical failures of the suspension system, but also by the effects of the suspension limitations on the crew.[20]

Based upon the findings of these studies, it can be concluded that the combination of suspension system failure and crew tolerance to absorb shock and vibration, constitutes a major factor for limiting the cross country speed of the M60A1. Furthermore, since the tests were conducted at speeds of 8-24 miles per hour this "...surely indicates that slower speeds would have to be used in battle."[21]

The 1972 study additionally revealed that while the suspension system of the M60 series tank was a definite handicap over the cross country courses, its speed and movement were also hampered by the power train. During the test, the M60A1 incurred power limitations approximately 80 to 90 percent of its total travel time. In fact, the study noted that when maneuvering through wooded areas, "...the throttle was in the wide open position most of the time," and that the drivers had to use downshift techniques to maintain engine RPM for maximum steering capability.[22] Further affirmation of this cross country power limitation was found during HELAST I, which required M60 series tanks to conduct offensive tactical movements cross country. During the conduct of the test, it became obvious that the attacking tanks failed to move quickly from cover to cover. When the tank

commanders were queried as to why they had permitted long exposure times during cross country movement, the invariable answer was that "...the vehicle was not capable of going faster because of limited power."[23] Through close observation, an assessment of the designated attack routes confirmed the following about the M60 series tank:

1. On most terrain, it is power limited if the gradient or slope is greater than five percent.

2. In regard to acceleration and agility, it is strictly power limited over the vast majority of terrain types and in most tactical situations.

3. When operating in mud it is greatly power limited because a large percentage of total available power is consumed, not just in moving the mass of the tank, but in over-coming the forces of resistance from the mud-encrusted tracks and driving systems.[24]

The relationship of cross country terrain to the ability of the M60A1 to move at its maximum rate of speed is graphically illustrated in Figure five. As one can see, the speed of movement of the M60A1 is inversely proportional to the difficulty of the terrain, and its actual cross country speed is degraded to approximately one-fourth of its optimum.

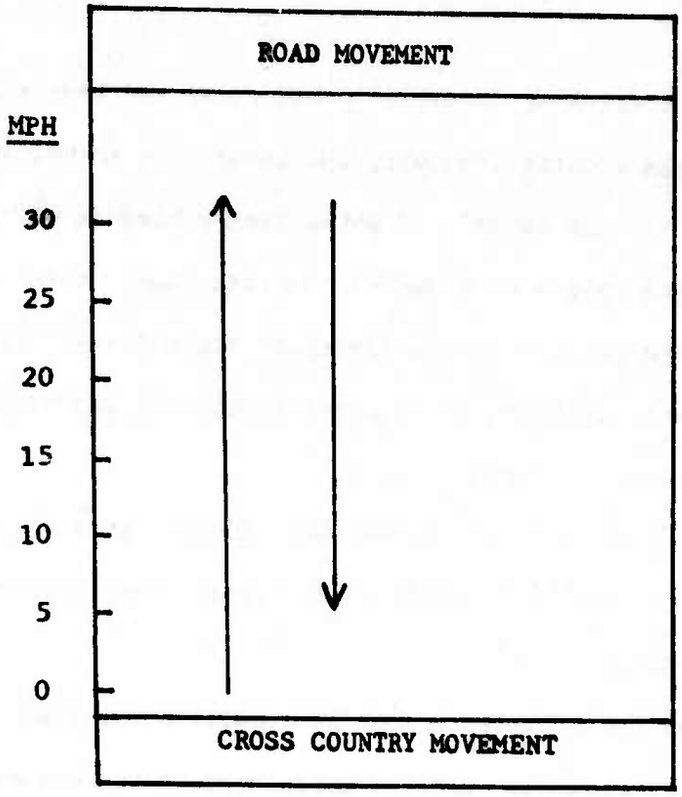


Figure 5

Cross Country Movement/
Speed Relationship

In regard to obstacle clearance, the movement of the M60A1 is further constrained. The M60A1 has a maximum horizontal obstacle clearance of 8.5 feet and a maximum verticle obstacle clearance of only three feet. Its fording depth is limited to only four feet without preparation.[25] It goes without saying, then, that manmade obstacles such as towns, cities, and destroyed bridges significantly impede the M60A1's speed of movement. Further, one cannot exclude minefields. Their use in past wars, planned employment, and improved capabilities indicate that mining operations will significantly reduce the battlefield mobility of the tank, and, as such, constitute one of the corner-

stones of antiarmor defense.[26] When integrated with such natural terrain obstacles as the heavily wooded areas, mountains, inundated areas, streams, and rivers that are indigenous to Central Europe, the ability of the M60A1 to optimize its potential mobility is uncertain to say the least.

TOW Cobra. The TOW Cobra totally eliminates the effect of terrain and obstacle clearance on the speed of movement that plagues the M60A1. Because of its airborne mode of movement it has turned upside down the problem of terrain and obstacle clearance; a problem, which, through all history, has governed all ground combat tactics in the most profound way.[27] By its ability to take to the air, the TOW Cobra makes terrain work for it, and, as General Hamilton Howze remarked, "It is quite impossible to exaggerate the effect of this advantage."[28]

Due to its independence of the ground, the TOW Cobra can optimize its cruising speed of 150 knots per hour. Even if forced by enemy air defenses to fly nap-of-the-earth (NOE), a survival altitude that generally follows the contours of the earth as close as vegetation or obstacles permit, its movement is still at a rapid speed of 50 knots per hour.[29]

Weather is the only environmental variable that can affect the mobility of the TOW Cobra. Ceilings of less than 200 feet, and visibility of less than one-half mile restrict its flight capabilities; also, visibility of less than one mile limits its ability to engage enemy targets. Winds in excess of 40 knots result in the grounding of the TOW Cobra, and wind gusts in excess of 30 knots restrict its

employment in certain types of terrain.[30] The operational radius and payload of the TOW Cobra may also be decreased by atmospheric pressure and temperature.[31]

Studies reveal, however, that the impact of weather upon the TOW Cobra's capabilities may be over-stated. To determine the operational capabilities of the attack helicopter in European weather, meterological records were examined for 16 locations dispersed throughout Western Europe. The weather data analyzed covered 24-hour periods over a ten year span. This study revealed that the minimum flying conditions of the TOW Cobra could be met 91 percent of the time, even during the worst weather months of November and December. Furthermore, during the evaluation period itself, the European weather favored the employment of the TOW Cobra 99 percent of the time.[32] Thus, as established, a greater percentage of heliborne operations can be conducted throughout the year in Western Europe than generally expected.

The mobility relationship of the M60A1 and TOW Cobra is shown in Figure six:

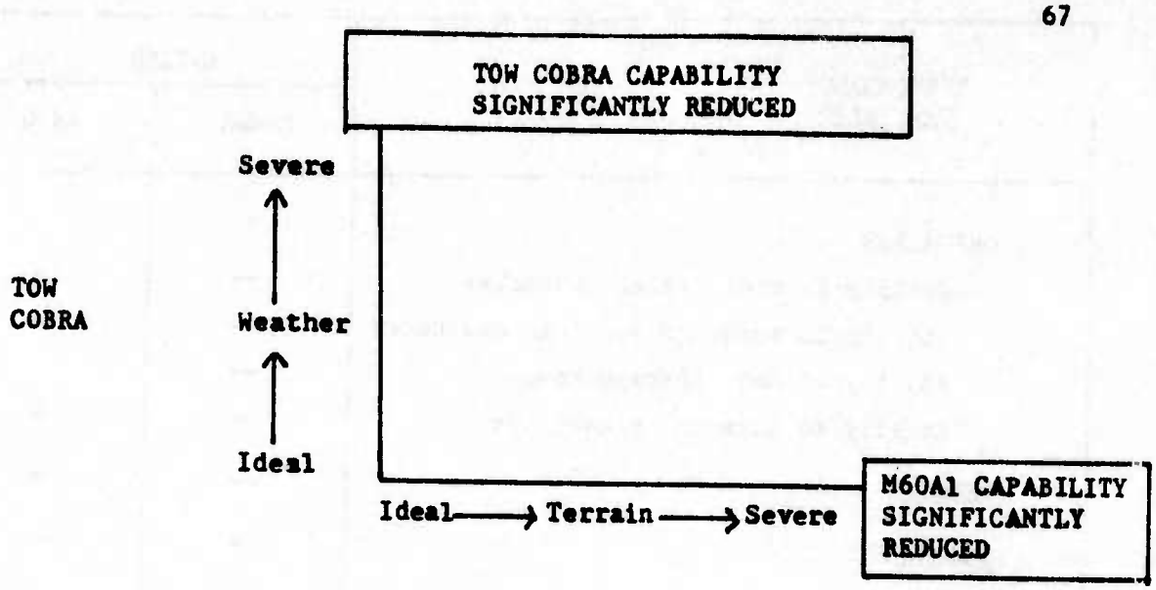


Figure 6

Mobility Relationship[33]

Summary. Both the M60A1 and TOW Cobra, in terms of systems design, are capable of responding rapidly to tactical requirements. However, as depicted in Figure six, the M60A1 is designed to operate under all weather conditions but is severely limited by manmade and natural terrain restrictions. On the other hand, the TOW Cobra is completely independent of terrain but affected by adverse weather conditions. Nonetheless, the TOW Cobra, with its indifference to terrain composition and terrain profile, has a cruise and dash speed capability that gives it a marked differential over the M60A1. As a result, the TOW Cobra, even if forced into a NOE survival altitude, can reach the engagement area in approximately one-sixth the time it takes the M60A1 under battle conditions.[34] Therefore, as illustrated by the performance variables of tactical mobility in Table five, the TOW Cobra is clearly superior to the M60A1 in its ability to move rapidly from point to point in the battle area.

PERFORMANCE VARIABLES	RATING	
	M60A1	AH1Q
OBSTACLES		
Ability to cross water obstacles	--	+
Ability to surmount verticle obstacles	--	+
Ability to move through towns	--	+
Ability to surmount minefields	--	+
TERRAIN	--	+
WEATHER	+	--
HIGH SPEED MOVEMENT	--	+
RESPONSE TIME	--	+
COMBAT RADIUS	+	--

+ = Advantage

-- = Disadvantage

Table 5

Mobility Effectiveness Matrix

Firepower

Firepower is decisive since the achievement of superiority on the battlefield is dependent upon the ability to paralyze the enemy source of fire before he can employ it.[35] When combined with movement, the two represent the fundamental elements of combat. Today, fire and movement are integrated and simultaneously executed in both the main battle tank and the attack helicopter.[36] The firepower of these particular weapons systems, however, differ in their

main armament. The extent of this difference will be assessed by comparing the performance variables of lethality, accuracy, time of flight, rate of fire, and number of rounds carried.

Lethality. The main armament of the M60A1 is the 105mm rifled gun, and the main armament of the TOW Cobra is the TOW anti-tank guided missile (ATGM).

As depicted in Figure seven, the probability of kill, given a random hit on an enemy tank by either an antitank guided missile or projectile, is constant at all ranges with neither weapon having an advantage. Therefore, the M60A1 and TOW Cobra main armaments, in terms of lethality, are relatively equivalent since both retain an acceptance level of kill probability for the defeat of armor throughout the interval of range considered.

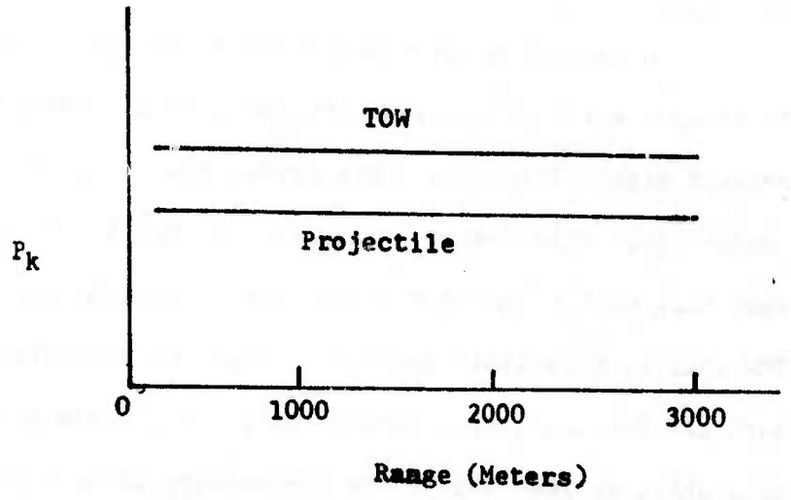


Figure 7

Probability of Kill (P_k) Given
A Random Hit On A Tank 37

Accuracy. The results of countless tests and firings of the TOW antitank guided missile and the 105mm gun/projectile system is shown in the figure below.

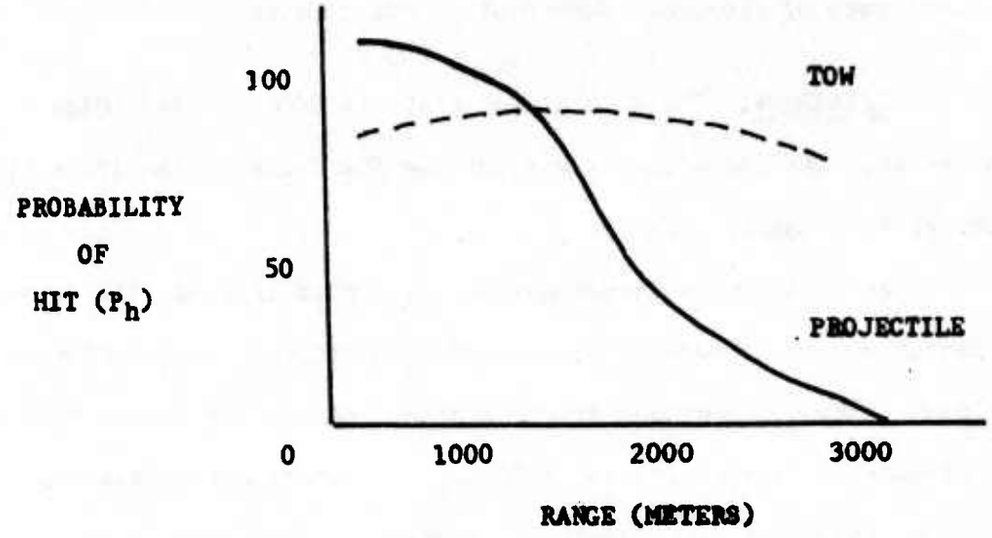


Figure 8

Effectiveness Vs Range[38]

In assessing the probability of hit as a function of range, it is apparent that the TOW antitank guided missile has a relatively higher first round hit probability than the 105mm gun/projectile. This higher probability of hit is derived from the fact that within the 3000 meter range spectrum, the accuracy of the TOW remains relatively constant. Thus, at approximately 1500 meters both the TOW and gun/projectile have a 1:1 ratio of probability of hit, while at 2000 meters the probability of hit for the TOW, compared to the gun/projectile, is increased to a favorable ratio of 3:1.

In contrast, the accuracy of the M60A1 105mm gun/projectile system does not remain constant at all ranges. For

stationary targets at ranges of less than 1200 meters, the gun/projectile has a slightly greater probability of hit than the TOW. However, at ranges beyond 1500 meters the accuracy of the gun/projectile drops off sharply to a less than fifty percent probability of hit. For moving targets a better than fifty percent probability of hit cannot be achieved beyond ranges of 800-1000 meters.[39]

Relative to accuracy, however, other performance factors and differences must be considered. In this regard, the most obvious difference between the TOW and the 105mm gun/projectile is the manner in which they are sighted to obtain a hit.[40] For the TOW Cobra, the sighting and firing process is as follows:

1. The gunner acquires and tracks the target with stabilized sights.

2. The pilot, at this point, momentarily aligns the aircraft with line-of-sight.

3. The gunner fires the missile which automatically guides along the gunner's line-of-sight to the target.

4. After launch, the pilot is free to maneuver the aircraft but must insure that the aircraft's position retains the gunner's line-of-sight to the target.[41]

The important advantage gained from the TOW's manner of sighting is that it enables the gunner to make inflight corrections, insuring a significantly high probability of hit. Consequently, the TOW Cobra system is particularly accurate at long ranges and against moving targets.[42]

Relative to sighting accuracy, the probability of hit is a near certainty only as long as the gunner can see the target and

control the missile. Therefore, a target hit, is dependent on the commands transmitted to the missile from the sight picture of the gunner throughout the flight to target impact.[43] This important and critical command link can be affected in three ways. First, the gunner's line-of-sight to the target may be impaired by battlefield obscuration. Secondly, since the TOW antitank missile produces a blast signature and the vertical/horizontal manauver capability of the TOW Cobra is limited by the requirement to maintain line-of-sight during the missile's flight, gunner distraction will undoubtedly be induced by enemy action.[44] Lastly, since the TOW antitank missile is wire guided, there exists the possibility that in densely vegetated terrain the command link may be severed by the entanglement and breaking of the guidance wire.

The advantages and disadvantages of the M60A1's 105mm gun/projectile are related to the fact that it is a fire and forget system. Consequently, a hit or miss is dependent upon the sight picture at the moment of firing. At long ranges, this is a significant disadvantage relative to probability of hit in that it does not allow for correction of the initial sight picture and does not allow the gunner to compensate for changes in target speed or direction.[45] At very short ranges, however, the gun/projectile accrues a greater advantage over the TOW antitank guided missile since it requires some distance (approximately 500+ meters) for the gunner to gain control of the moving round. Furthermore, the gun/projectile system is less affected by the limiting factors of battlefield obscuration and enemy action in that it does not require any sight adjustments after firing.[46]

Time of flight. The third firepower performance variable to be examined is time of flight from launcher to target. In this regard, Figure nine demonstrates that a significant difference exists between the TOW and 105mm projectile. While the flight time of the 105mm projectile remains relatively constant, at all ranges, the flight time for the TOW missile increases with range. As a result, the flight time for the TOW missile, at its optimum range of 3000 meters, is approximately fourteen seconds. This time delay, under combat conditions, constitutes a shortcoming that serves to degrade the overall ability of the TOW Cobra to effectively engage enemy tanks.

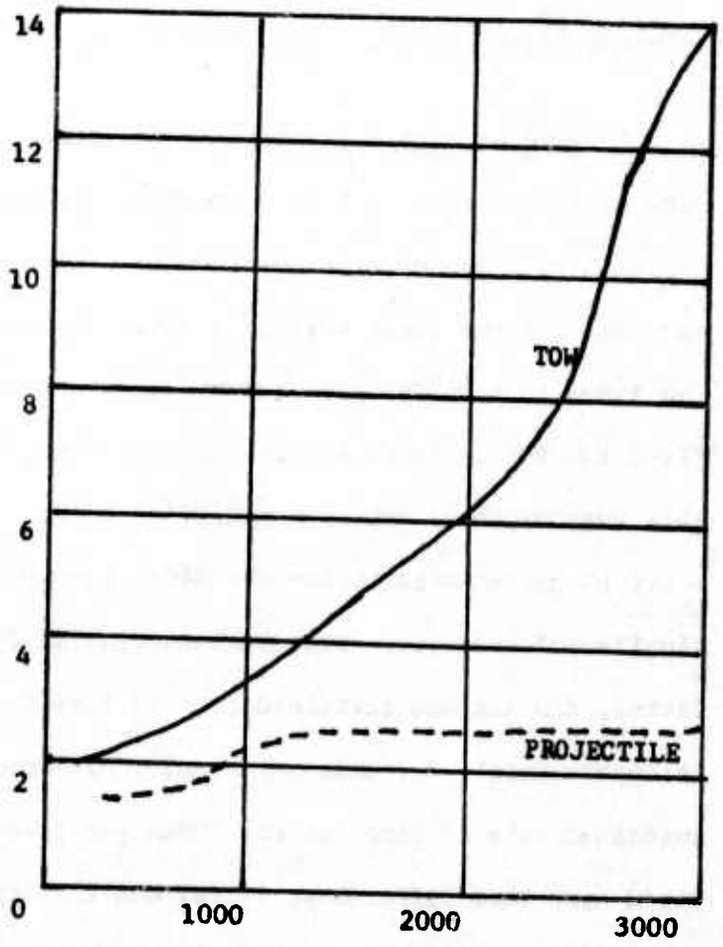


Figure 9

Time of Flight As A Function Of Range 47

In this regard, consider the question: How far can a tank target travel in 10 or 15 seconds, assuming it is moving at a speed of 30 miles per hour? For a flight time of 10 seconds, say the target can travel approximately 450 feet.[48] Since the TOW's sighting system requires the gunner to keep the target in line-of-sight throughout flight, a second question arises: What is the probability that the gunner will be able to maintain this target in his sight for the 10 second flight time while the target is moving?[49] Any answer to this question is not a promising one for effectiveness. For it must be assumed that the chances for the TOW antitank missile to arrive on target would beconsiderably lessened by the action of the enemy to return fire and/or to take every advantage of the terrain for cover and concealment.[50]

Rate of fire. Implicit in the time of flight variable is rate of fire. Rate of fire represents the number of rounds that can be fired by a gun or missile armament system in a prescribed time, and includes the total time to acquire the target, load, and fire. The times to fire for guns and missiles are nominally the same for the first run but increase slowly with the range of engagement.[51] In this regard, there exists a significant disparity between the TOW antitank guided missile and the M60A1 gun/projectile, since the TOW missile--of necessity--must include time of flight. Due to this factor, the maximum sustained rate of fire for the TOW at 2000 meters is approximately 2 rounds per minute. In comparison, the maximum sustained rate of fire for the 105mm gun is 6 rounds per minute.[52] Based upon this difference, it follows that the 105mm gun can deliver more rounds on target than the TOW system.

Number of rounds carried. Any sustained rate of fire is dependent upon the number of rounds carried by the weapons system. Consequently, this variable represents the greatest disparity between the firepower systems of the M60A1 and the TOW Cobra. The M60A1 carries a total of 63 rounds. The TOW Cobra, in comparison, carries only 8 antitank missiles. The effect of this disparity rather obviously establishes the fact that the M60A1 has a far greater battlefield endurance; a factor which the Israelis, in 1973, used to their advantage against the masses of Soviet built tanks that carried a lesser number of rounds.

As illustrated in Figure ten, it is apparent that each armament system has both shortcomings and desirable characteristics. The standoff distance afforded by the TOW antitank guided missile is a significant advantage on the modern battlefield where "what can be seen, can be hit; what can be hit, can be killed."[53] On the other hand, the gun/projectile is capable of supplying a high rate of fire and accuracy at short ranges for longer periods of time. This capability is especially significant in view of World War II combat data and the findings of recent field experiments. Both have indicated that due to the problem of intervisibility, the greatest percentage of tank engagements (95%) will occur between 1000 and 1500 meters.[54]

PERFORMANCE VARIABLES	RATING	
	M60A1 (105mm)	TOW COBRA (TOW ATGM)
LETHALITY	+	+
ACCURACY		
LONG RANGE	--	+
SHORT RANGE	+	--
TIME OF FLIGHT	+	--
RATE OF FIRE	+	--
ROUNDS CARRIED	+	--
DEGRADATION SUSCEPTABILITY	+	--

+ = Advantage

-- = Disadvantage

Figure 10

Firepower Effectiveness Matrix

PROTECTION

The last measure of effectiveness to be evaluated is the protection afforded by vehicle design. As evident in the evaluations of mobility and firepower, protection must be an integral part of any weapons system if it is going to operate effectively on the battlefield and survive. Protection is basically of two kinds--ballistic and nuclear-biological-chemical (NBC).[55] Although the ballistic protection of the M60A1 is vulnerable to the antitank round or

missile, it is inherently protected all around from all calibers of small arms, light cannon, and ground impact artillery fragments. On the other hand, the TOW Cobra only provides ballistic protection from small arms for the crew and critical components of the aircraft.

Concerning NBC protection, the TOW Cobra is extremely vulnerable due to the fact that the performance parameters do not include this requirement in its design capabilities. To the contrary, the M60A1 can operate and survive in a NBC environment. The weight, solidity, and profile of the M60A1 enables it to withstand the shock wave following a nuclear explosion better than any other vehicle. The armor skin of the M60A1 protects the crew from the thermal effects of a nuclear weapon, serves to attentuate the initial gamma radiation, and provides a barrier against fallout dangers. Similarly, the armor skin of the M60A1 affords protection against chemical and biological agents.[56]

Although NBC is not within the definitive parameters of mid-intensity conflict, this aspect of protection must be considered when measuring the effectiveness of a weapons system. This contention is based upon two obvious facts. First, throughout the Soviet writings concerning strategy and tactics, the employment of nuclear weapons is <u>prima facie</u>. Secondly, the organizational and training emphasis given to chemical warfare makes its employment appear somewhat less than remote. Thus, the main battle tank, relative to protection, represents the "...sole means of combining a certain mobility and some chances of survival in the atmosphere that a modern combat may involve."[57]

In recalling the formula stated earlier, Wd x Te = QA,

hypothesis two will be tested in terms of Te, and is restated as follows:

> RELATIVE TO THE EUROPEAN THREAT, CAN THE TOW COBRA ATTACK HELICOPTER COMPENSATE FOR NATO'S QUANTITATIVE INFERIORITY OF MAIN BATTLE TANKS BY OPTIMIZING ITS CAPABILITIES THROUGH TACTICAL EMPLOYMENT.

This sub-hypothesis will be assessed by employing survivability as a measure of effectiveness relative to the tactical threat confronting the M60A1 and TOW Cobra.

Survivability

In regard to the M60A1 and TOW Cobra, the tactical threat spectrum is depicted in Figures eleven and twelve.

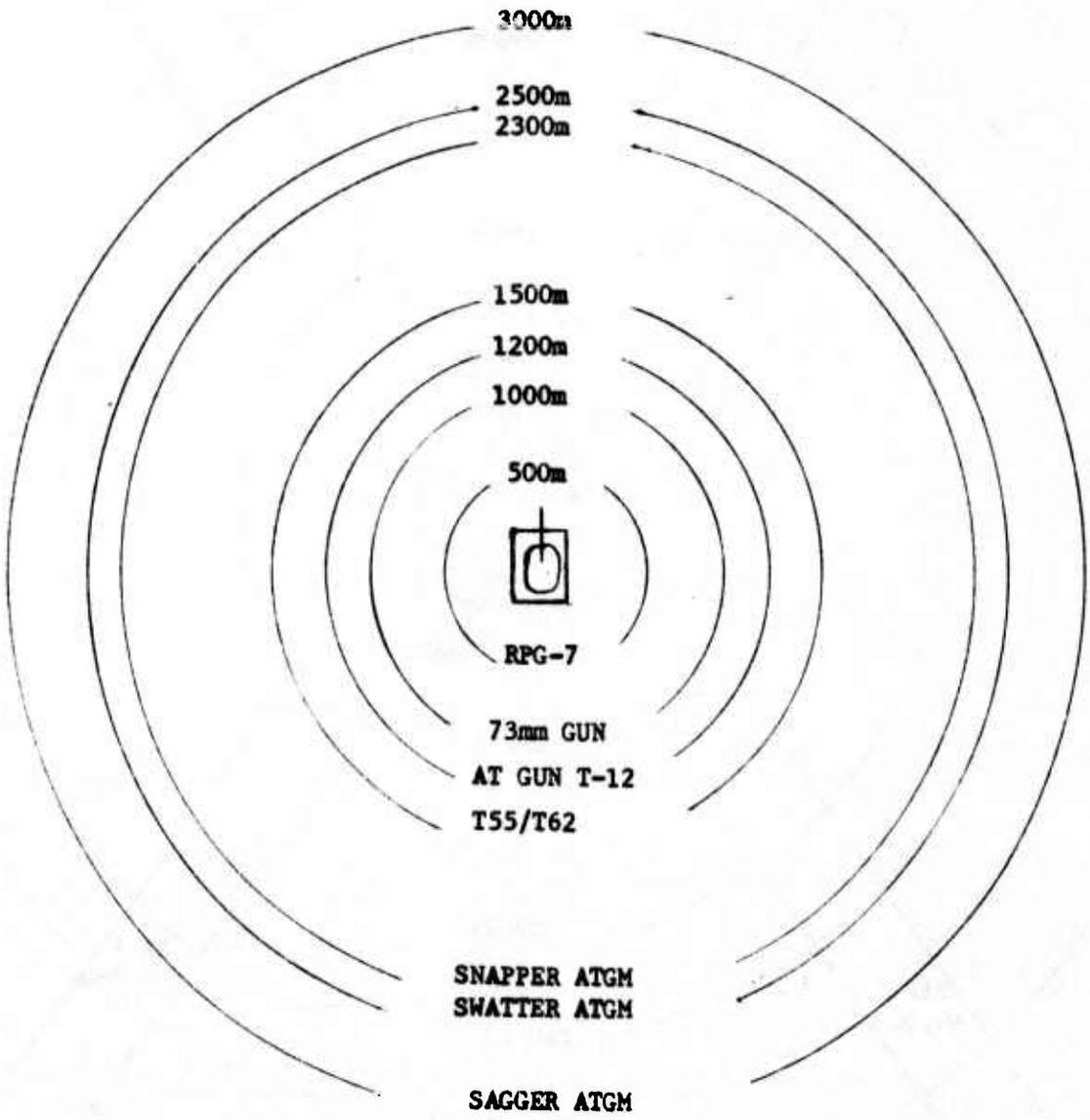


Figure 11

Threat Antiarmor Weapons Spectrum[58]

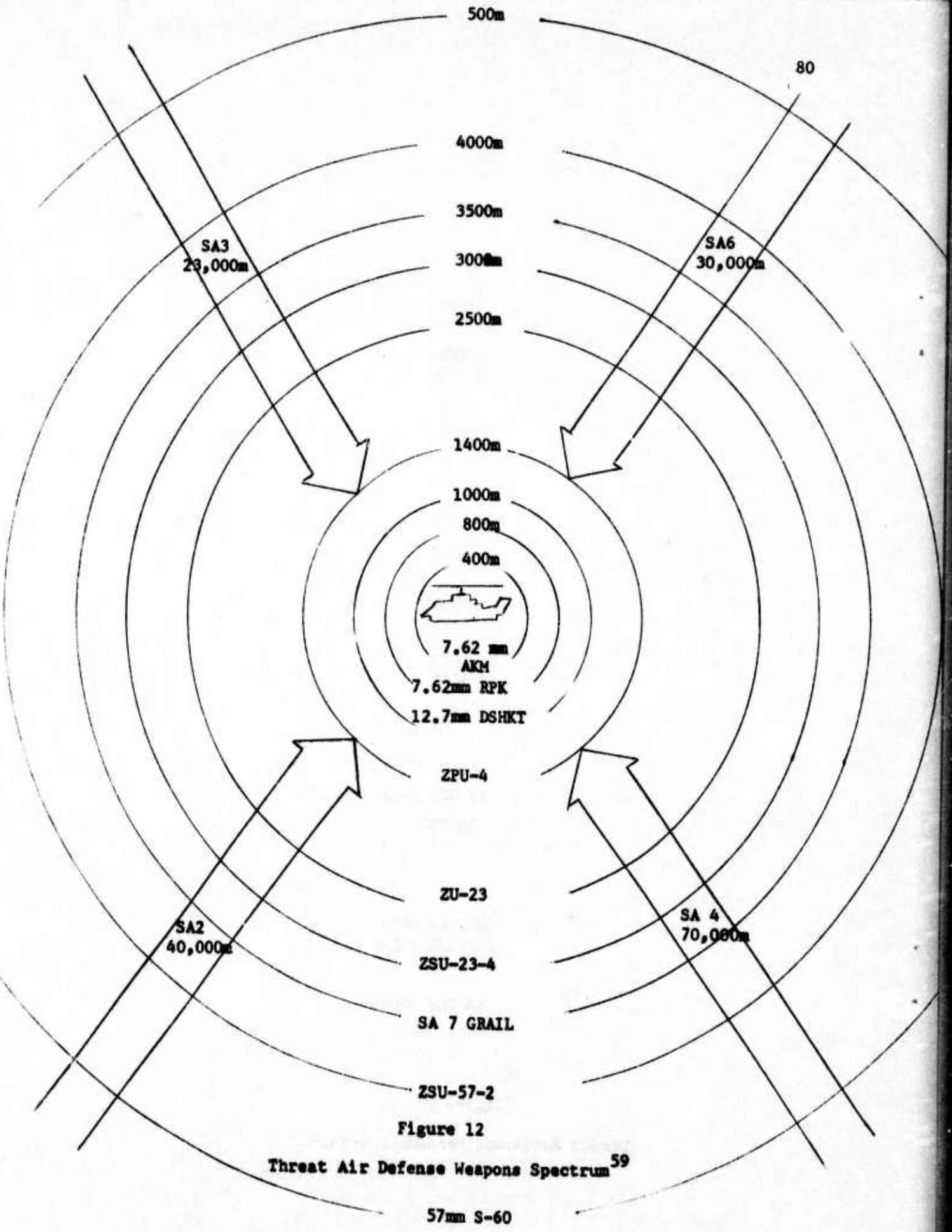


Figure 12

Threat Air Defense Weapons Spectrum[59]

As depicted, one can see that the TOW Cobra is exposed to a significantly wider variety of threats than the M60A1. Furthermore, when this spectrum of threat is coupled with the fact that the TOW Cobra has limited ballistic protection from small arms, light cannon, and artillery fragments, it appears to be inherently more vulnerable to destruction than the M60A1. However, as Major General Thomas M. Tarpley, Commandant of the U.S. Army Infantry School, affirmed:

> We firmly believe the vulnerability of any system must be considered in relation to its contributions to the destruction of the enemy and it must be compared to the vulnerability of other means accomplishing the same mission. [60]

Therefore, the survivability of the TOW Cobra vis a vis the M60A1 is a product of both systems vulnerability and the ability to extract a favorable kill ratio of enemy forces. In this regard, the variables selected for evaluation are combat agility and tactical techniques.

Combat Agility

Combat agility is defined in terms of those attributes that decrease (or increase) the likelihood of being hit by a projectile fired from an opposing weapons system.[61] Basically, these attributes that permit the combat vehicle to avoid enemy fire are related to its ability to start, stop, and maneuver quickly as it moves from point to point.

The basic element for survival, as determined by the Human Engineering Laboratory HELAST II test, is the enemy gunner's ability to differentiate between what is apparent and what is real.[62]

As illustrated in Figure thirteen, there exists a mobility bias that denotes the difference between where the enemy gunner aims at the time of fire and where the target vehicle is at the time of projectile impact. The value or variance of this mobility bias is a function of the speed and range of the target vehicle.[63] For example, when the moving target vehicle is at long range, the gunner has difficulty in differentiating between what is apparent and what is real. As a result, the gunner fires on what is apparent--and has some chance of hitting what is real. At shorter ranges and with slower target vehicles, what is apparent begins to approach what is real.[64]

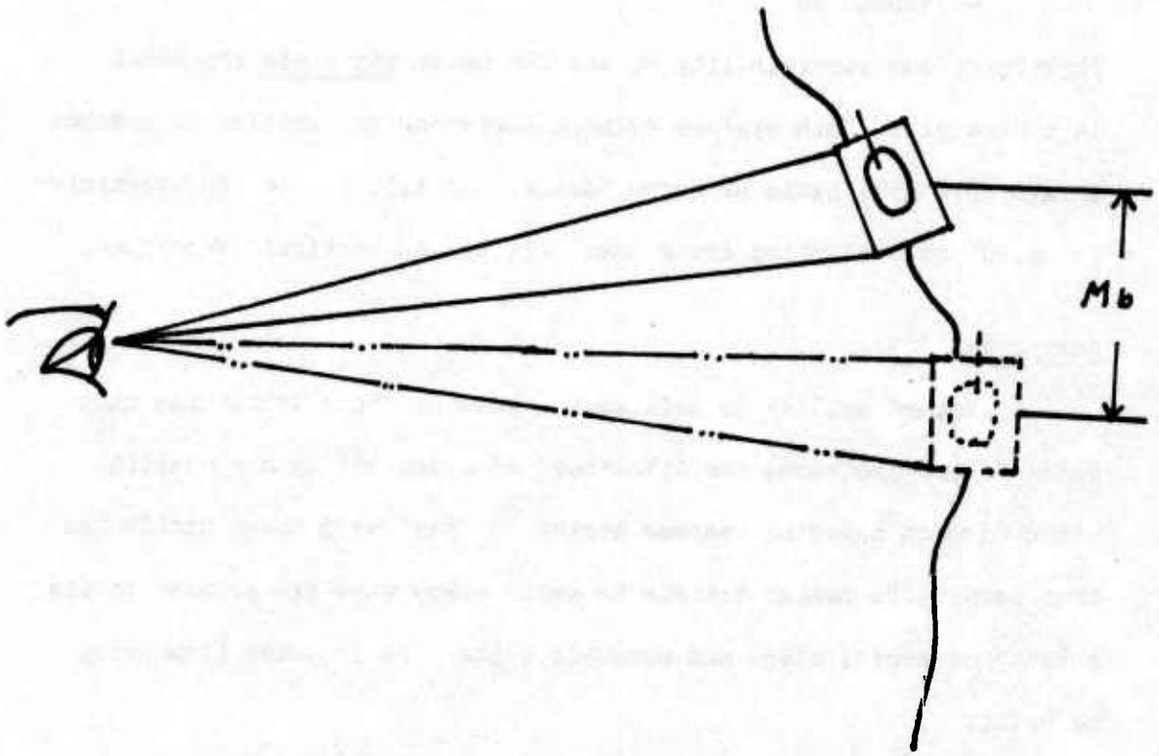


Figure 13

Mobility Bias (Mb)[65]

In considering mobility bias as a function of range, the relationship of combat agility to the survivability of the TOW Cobra and M60A1, becomes readily discernible. Since it cannot deal efficiently with targetsaat extended ranges, the standoff range of the M60A1 will invariably be at distances of 1500 meters or less. In comparison, the greater range capability of the TOW Cobra affords it a standoff distance of 3000 meters.

Mobility bias, as a function of speed of movement, also reveals that the combat agility of the TOW Cobra is superior to the M60A1. Speed of movement is related not only to the ability of a vehicle to move quickly from point to point, but to its ability to start, stop, and turn quickly. In this respect, the TOW Cobra has superior combat agility. This superiority is derived from the fact that the TOW Cobra is independent of terrain and ground obstacles, whereas the inherent capabilities of the M60A1 are limited by its confinement to the ground. These terrain limitations become even more significant when considering the fact that the lethality of modern weapons has made the survival of the tank dependent upon its ability to use every fold of the ground.[66] The tank, out of necessity, will have to move cross country, seeking terrain which is anything but ideal for optimizing its mobility. For as determined earlier in the systems performance analysis of the M60A1, its cross country suspension and power limitations reduce the optimum speed of movement by approximately 70-75 percent.

In sharp contrast, the TOW Cobra, free of the terrain, can quickly traverse large areas and obstacles including mountains, waters, and even congested or destroyed lines of communications at

combat speeds ten times greater than the cross country speed of the M60A1.[67] Unlike the M60A1, the TOW Cobra can seek the cover and concealment of the rolling terrain to avoid a majority of the threat air defense spectrum without any significant degradation in its combat agility by employing the nap-of-the-earth survival altitude. Although survival altitude, which is at the 50 to100 foot level, increases the TOW Cobra's vulnerability to small arms fire, it is more than compensated by the TOW Cobra's rapid ability to alter its speed and direction, both horizontally and vertically. This factor enhances survivability by increasing the mobility bias of the enemy gunner. Thus, the TOW Cobra, unlike the M60A1, can use the irregular terrain habitually found in Central Europe to increase survivability, while maintaining its freedom of movement.

Although the M60A1 is designed to fight and survive in close proximity to the enemy, the modern battlefield axiom, "what can be seen, can be hit; what can be hit, can be killed" must be kept in mind. In relation to this axiom, mobility becomes synonymous with survival in that the ability to operate at extended ranges with greater speed and acceleration capabilities increases the mobility bias of the enemy gunner. This factor, coupled with the fact that the TOW Cobra can optimize its capabilities of speed, agility, and standoff engagements, indicates that its vulnerability on the modern battlefield is not significantly greater than the M60A1.

Tactical Technique

As stated earlier, survivability is also measured in terms of the defender's ability to destroy the enemy on a favorable exchange ratio. In this regard, the defending force can accrue a

significant advantage through the tactical technique of firing the first round in a tactical engagement. Figure fourteen, based on approximately 300 World War II platoon-to-company-size armor engagements in France, shows the importance of first-round engagement. As it can be seen, the defending force outnumbered 2:1, but firing first, will have considerably more success than an attacker with a 5:1 superiority but firing second.[68] This historical data is further supported by the findings of the Ansbach Test. In this test, the defending force was able to achieve significantly high kill ratios against an advancing armored force by firing the first round from ambush.

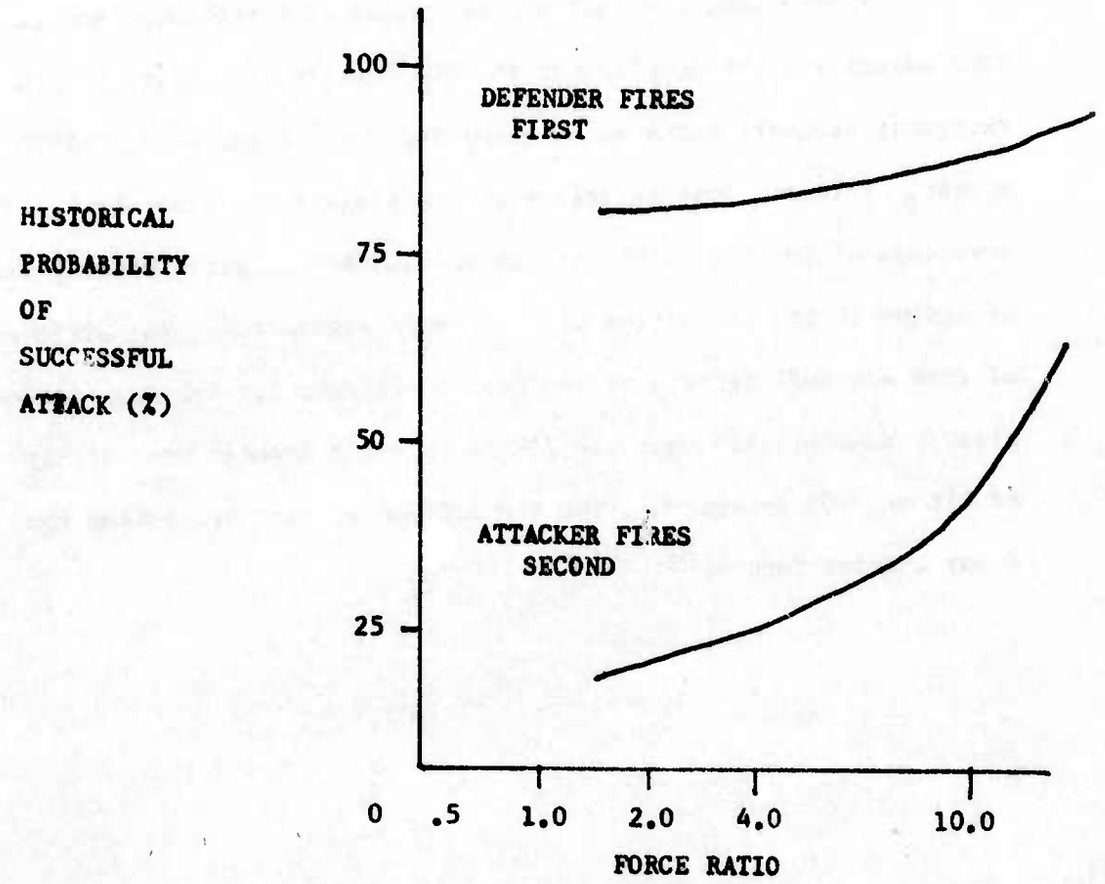


Figure 14

First and Second Round Engagement Results 69

Detection and target acquisition is greatly governed by range. Consequently, it is posited that the M60A1 would not be able to attain a high percentage of undetected ambushes because it must close to within 1000-1500 meters to achieve a fifty percent probability of hit. At this range, the vulnerability of the M60A1 is also increased by virtue of the fact that it is within the effective range of the entire threat antiarmor spectrum, excluding the RPG-7. Thus, in measuring tactical effectiveness against range, the M60A1 does not have a cross-over advantage against the enemy force. This factor certainly reduces its probability of firing undected from ambush and attaining a first round hit.

In contrast, the tactical technique of first-round engagement from ambush greatly complements the TOW Cobra's capability to place extremely accurate fires on an enemy force at ranges of 2000-3000 meters. This tactical technique also optimizes the cross-over advantage of the TOW Cobra and, as such, enhances survivability by affording it the protection of a standoff engagement. The advantage of this standoff factor, as depicted in Figures fifteen and sixteen, clearly demonstrates that the TOW Cobra has a greater probability of hit at 3000 meters than the air defense weapons protecting the enemy armored forces.[70]

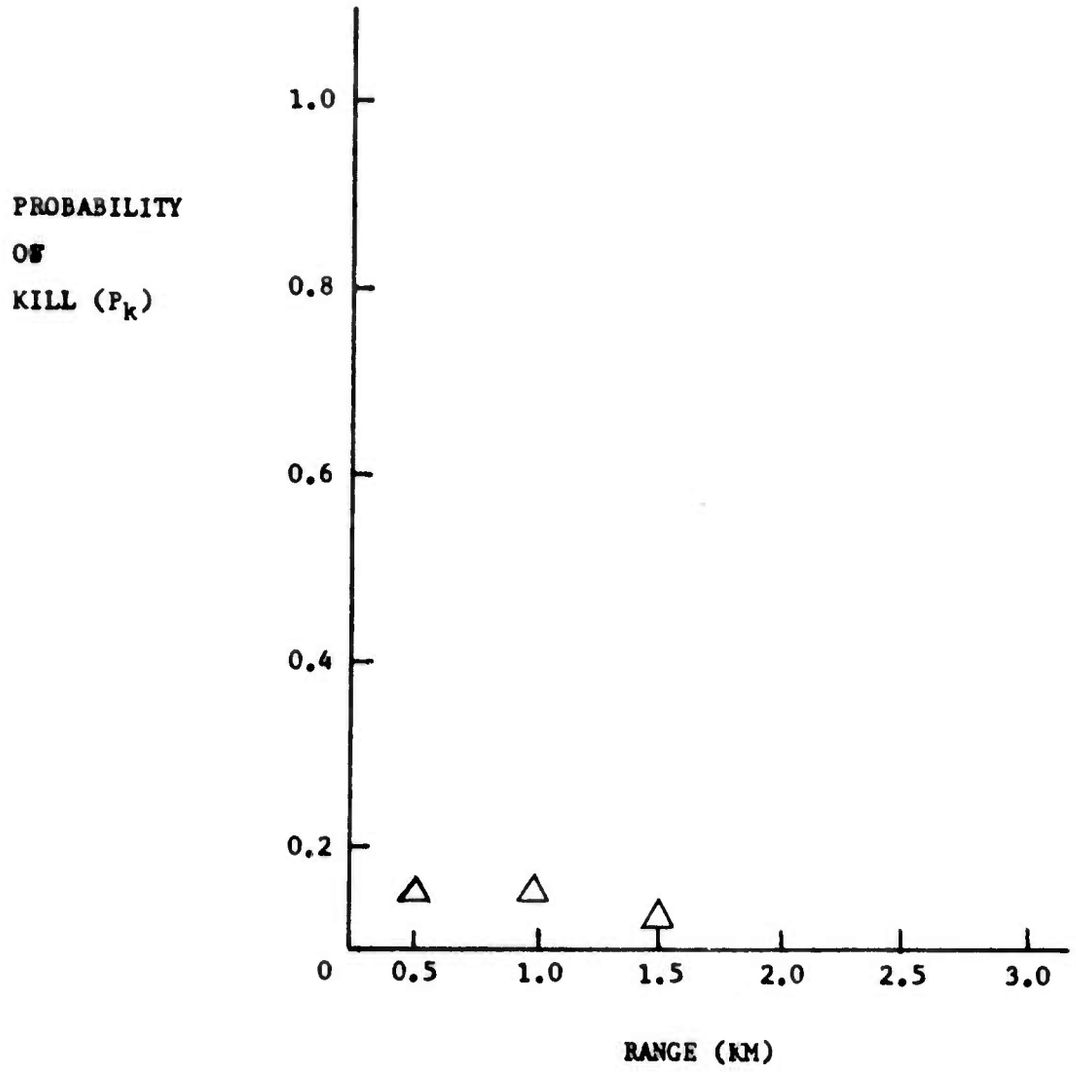


Figure 15

Kill Probability of 12.7mm
Machinegun Simulator 71

Basis: Crossing helicopter: 20 second exposure (6-8 seconds of fire). Total of 100 engagements at each range.

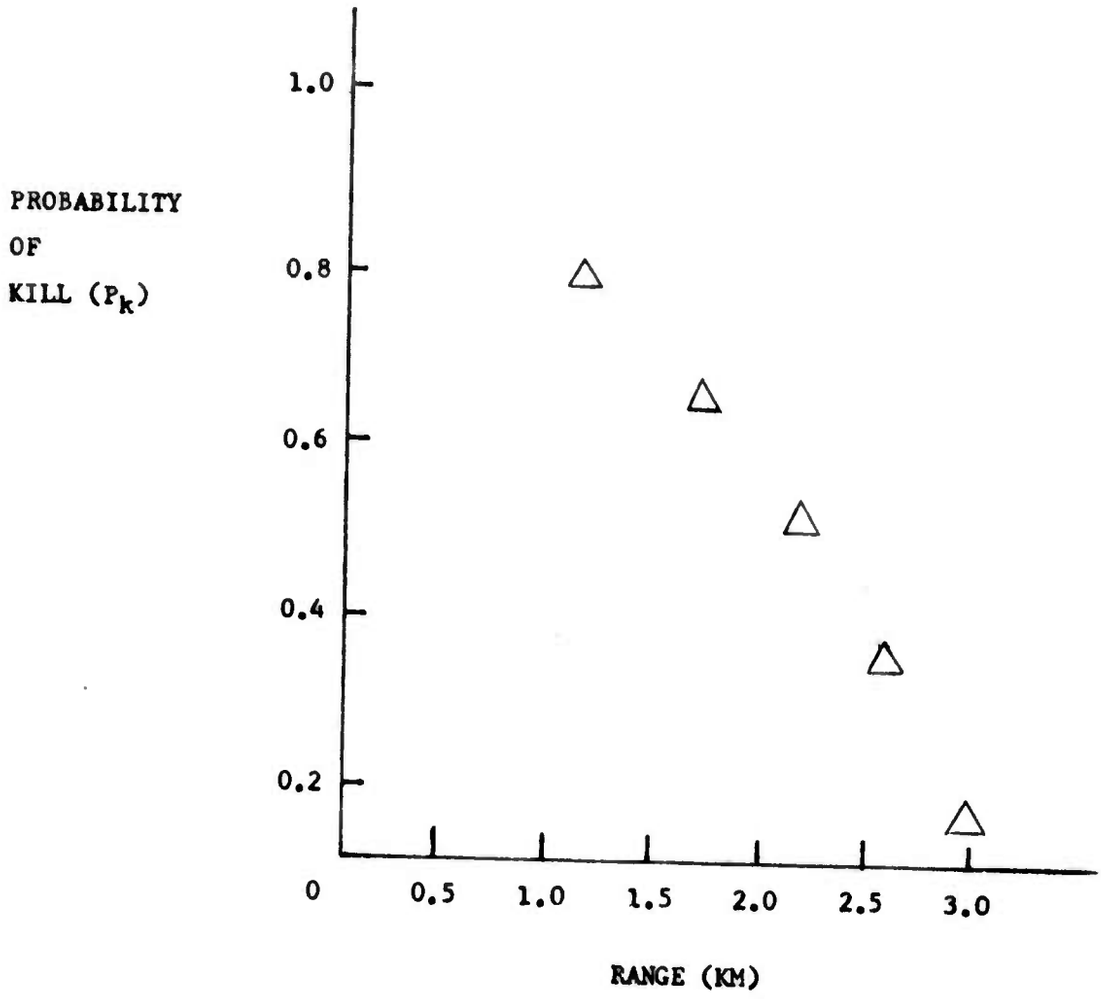


Figure 16

Kill Probability ZSU-23-4
Simulator 72

Basis: Hovering, frontal helicopter: 20 second exposure (approximately 6 seconds of fire). Total of 100 engagements at each range.

First-round engagement from ambush also optimizes the vertical mobility of the TOW Cobra. Able to acquire targets that are masked to ground weapons systems and to gain target intervisibility earlier, the TOW Cobra can subject a greater number of targets to long range, accurate fires from ambush. Thus, when compared to the M60A1, the TOW Cobra's measure of effectiveness relative to survivability is greater when employing the tactical technique of first-round engagement from ambush.

Summary

Technological improvements are constantly being explored to keep the main battle tank and attack helicopter "alive" on the battlefield. But with each new device, aand each costly improvement, a countermeasure is always found. Thus, it is time indeed that it is realized nothing is more vulnerable on the battlefield than the individual infantryman. However, he survives by the skillful combination of fire and maneuver.[73] Similarly, the key to the survival of the tank and attack helicopter resides in the ability to optimize their firepower and mobility capabilities. This will not only enhance their survival on the European battlefield, but will also provide NATO ground forces the qualitative advantage to overcome their quantitative inferiority of main battle tanks.

CHAPTER IV

FOOTNOTES

1. Philip J. Murphy, "Thesis on Future Military Design--A Forecast of Combat Vehicle Systems," Technical Report No. 11737, Mobility Systems Laboratory, U.S. Army Tank Automotive Command, Warren, Michigan, January 1973, p. 2.

2. Jack N. Merritt and Pierrre M. Sprey, "Quality, Quantity, or Training," USAF Fighter Weapons Review, Command and General Staff College Instructional Publication M3121-12, 1974, p. 12-5.

3. Ibid.

4. Murphy, op. cit,, p. 25.

5. Ibid., pp. 2, 25.

6. MAJ Nicolas P. Vamvakias, "An Analysis of the Russian Armor Threat Facing U.S. Forces in Central Europe and a Determination of How to Counter This Threat During the 1971-1980 Time Period," Command and General Staff College Student Paper, April 1971, p. 23.

7. Ibid.

8. Ibid.

9. Merritt, op. cit., p. 12-6.

10. Ibid.

11. Ibid.

12. Ibid.

13. Ibid.

14. Ibid.

15. Ibid.

16. Andrew J. Eckles, III, "A Human Factors Review of Tactical Mobility - Combat Agility for the M60 Series Tank," Human Engineering Laboratory, Aberdeen Proving Ground, Maryland, Technical Notes 8-72, June 1972, p. 2.

17. K.W. Fisher, "Mobility Evaluation of Vehicle Types," Technical Note No. 1543, Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, July 1964, p. 5.

18. U.S. Army Armor School, Comparative Characteristics of Main Battle Tanks (Fort Knox, Kentucky, June 1973), p. 10-1.

19. Robert W. Fernstrom, Jr., et. al., "Cross Country Speed and Driver Vibrational Environment of the M60 Main Battle Tank," Technical Memorandum 7-65, Human Engineering Laboratories, Aberdeen Proving Ground, Maryland, July 1965, p. 8.

20. Eckles, op. cit.,

21. Fernstrom, op. cit., p. 19.

22. Eckles, op. cit., p. 4.

23. Ibid., p. 6.

24. Ibid., pp. 4-5.

25. Armor School, op. cit.

26. William G. Comeyne, Antitank Effectiveness of the U.S. Army Standard Minefield Pattern (U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, Virginia, April 1970), p. 2.

27. General Hamilton H. Howze, "Tactical Employment of the Air Assault Division," Army, 1963, p. 52.

28. Ibid.

29. Captain James P. Isenhower, Jr., "NOE-Survival Altitude," Infantry, November-December 1973, p. 18.

30. U.S. Army Infantry School, Antiarmor Tactics and Techniques for Mechanized Infantry (Fort Benning, Georgia, ST 23-3-1), p. A-14.

31. Colonel John B. Hanby, Jr., "Hellfire," Aviation Digest, January 1975, p. 26.

32. BDM Services Company, Tactical Helicopter Employment Study (THES) Vol. VII (Monterey, California, November 1973), pp. I-S-41-43.

33. U.S. Army Combat Development Command, MBTTF Support Study: An Examination of MBT/AAH Relationship (USACDC Armor Agency, Fort Knox, Kentucky, July 1972), p. 10.

34. Ibid., p. A-II-d-3.

35. H. Faugere, Soldati, et. al., "French Views of French and West German Armored Vehicles," U.S. Army Foreign Science and Technology Center, Washington, D.C., December 1970, p. 9.

36. Ibid., p. 19.

37. Bryant A. Dunetz, "Tank Gun or Missile?" Armor, March-April 1973, p. 38.

38. Ibid.

39. Ibid., p. 39.

40. Major General Orwin C. Talbott, "Gun or Guided?" Infantry, March-April 1973, p. 8.

41. U.S. Army Combat Development Experimental Command, "Attack Helicopter Daylight Defense, "USACDEC Experimental 436, Fort Ord, California, p. B4.

42. Talbott, op. cit., p. 9.

43. Ibid.

44. Ibid.

45. Talbott, op. cit., pp. 8-9.

46. Ibid., p. 9.

47. BDM Services Company, op. cit., p. K-29.

48. Dunetz, op. cit., p. 39.

49. Ibid.

50. Ibid.

51. Ibid., pp. 39-40.

52. Armor School, op. cit., p. 10-2.

53. U.S. Army Training and Doctrine Command, Range and Lethality of U.S. And Soviet Antiarmor Weapons TRADOC Bulletin #1, (September 1974), p. 3.

54. Dunetz, op. cit.

55. Faugere, op. cit., p. 8.

56. Ibid., p. 9.

57. Ibid.

58. U.S. Army Command and General Staff College, Appendix A, FM 100-5 (Test) (Draft), April 1975, p. A-7.

59. Ibid., pp. A-20 and A-25.

60. Dunetz, op. cit.

61. Bryant Dunetz and Dr. Ceslovas Masaitis, "Mobility and Survival," National Defense, January-February 1975, p. 319.

62. Ibid.

63. Ibid., p. 321.

64. Ibid., p. 320.

65. Ibid., p. 319.

66. FM 100-5, op. cit., p. A-5.

67. Major General Thomas M. Tarpley, "Airmobility in Mid-Intensity Warfare," Aviation Digest, July 1974, p. 10.

68. Merritt, op. cit., p. 12-7.

69. Ibid.

70. BDM Services Company, Vol. II, op. cit., p. K-29.

71. BDM Services Company, Vol. VI, op. cit., pp. I-K-239.

72. Ibid.

73. Howze, op. cit., p. 53.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

SUMMARY

Confronted with the threat of massive armored forces, NATO military theorists have adopted the tenet "...that the modern defense is first the battle against enemy tanks; therefore, it should first be organized as an antitank defense."[1] Related to this tenet is the inherent question of how should an antiarmor defense be organized or constituted. The question of how to stop and repel tanks was grappled with as early as 1932 in a series of lectures published by British Major General J.F.C. Fuller. General Fuller's concept of antiarmor defense, affirmed by the Soviet experience in World War II and resurrected by military thinkers in recent years, argues for defense in-depth built upon a proliferation of antiarmor weapons.

The official antiarmor doctrine of the U.S. Army, published in 1966, states: "...the best defense against a tank is another tank."[2] Although this maxim is being challenged by the advance of time and a new generation of antitank guided missiles developed for the armored battlefield, the recent U.S. Army Infantry School special text, concerned with the employment and integration of modern antiarmor weapons, acknowledges that the tank is still the decisive antiarmor weapon on the battlefield. Since the tank doctrinally remains the primary antiarmor weapons system on the battlefield, the proliferation of antiarmor weapons required by defense in-depth decrees that the U.S. Army

should attempt to correct the present imbalance of armored forces between NATO and the Warsaw Pact with more main battle tanks. Due to scarce fiscal resources, resulting from a recalcitrant American Congress and spiraling inflation, the capability of increasing the number of main battle tanks is not only infeasible but impossible. As a consequence, the attack helicopter has been proffered by many military leaders as the technological panacea for restoring "balance" with the quantitatively superior Warsaw Pact armored forces.

The advancement of the attack helicopter as the optimum solution for modern antiarmor defense is not a pipedream. Its conceptual validity has been affirmed and reinforced by numerous studies, field tests, and actual combat over the past decade. The benchmark studies which spanned this decade were the CARMONETTE model, the Ansbach Test, and the THES study. Despite the vagaries of time and methodology, these three studies arrived at a single point of commonality: the attack helicopter can execute its antiarmor role on the modern battlefield and survive. The validity of this hypothetical effectiveness of the attack helicopter was confirmed by Lamson 719. This combat test clearly demonstrated that the attack helicopter could survive in an intense air defense environment comparable to the mid-intensity level of conflict. Furthermore, it confirmed the fact that the attack helicopter could successfully engage and kill tanks.

Despite the validation of the attack helicopter's antiarmor role, many proponents of the tank still contend that the attack helicopter cannot technologically compensate for the existing quantitative imbalance of main battle tanks. In doing so, they have not

only raised serious doubts regarding the combat effectiveness and survivability of the attack helicopter in mid-intensity conflict, but have also inveighed an aura of competitiveness between the attack helicopter and main battle tank. The resultant effect has been a new tank-antitank debate that has, in too many instances, served to distort reality and to dispatch objectivity. As a result, the U.S. Army is presently stalled at the doctrinaire crossroads concerning the mission relationship of the main battle tank and attack helicopter in mid-intensity conflict.

FINDINGS

Due to the fact that the fundamental question of the research problem was concerned with the quantitative armored superiority of the Warsaw Pact vis a vis NATO, two fundamental hypotheses were conceptualized, stated, and tested.

1. Can the defeat of mass armored forces be independent of force ratios?

and, if so

2. How can the U.S. Army attain a favorable exchange ratio, within existing funding constraints?

In assessing the first hypothesis, the Lanchester square law, which states that success on the battlefield is dependent upon force ratio, was tested against direct empirical plots of historical win-loss results. The findings of this test concluded that quantity is not the sole determinant of success on the battlefield and that other factors can influence the ability of a force to extract a favorable exchange ratio against a numerically superior force. The

most significant of these factors, as demonstrated by history and recent experimental studies, is qualitative advantage.

In testing the hypothesis related to the question of how qualitative advantage can be attained, the equation: weapons design (Wd) x tactical employment (Te) = qualitative advantage (QA) was used. In this regard, since the TOW Cobra attack helicopter is held by many to represent the beginning of the end for the main battle tank's antiarmor role, its operational effectiveness was compared and contrasted with the M60A1 main battle tank. This comparative analysis assessed the M60A1 and TOW Cobra in terms of four common measures of effectiveness--mobility, firepower, protection, and survivability. This assessment disclosed the following findings:

1. The TOW Cobra is more responsive on the battlefield due to its superior mobility, whereas, the M60A1 has greater sustainability on the battlefield.

2. The major limitations of the M60A1 are terrain and obstacle clearance, while the major limitations of the Tow Cobra are weather and vulnerability.

3. Relative to firepower, the TOW Cobra has a greater probability of hit when employed at ranges in excess of 1500 meters. Conversely, the M60A1 has a greater probability of hit when employed at ranges of less than 1500 meters.

4. Survivability of the TOW Cobra is dependent upon its ability to conduct standoff engagements, whereas the M60A1's inability to conduct standoff engagements is compensated by its armored protection, affording it a greater chance of survival in engagements under fire.

CONCLUSIONS

Pertinent to the findings of the operational effectiveness analysis of the M60A1 and TOW Cobra, the following conclusions are drawn relative to the tank-attack helicopter in the European mid-intensity conflict environment.

1. The main battle tank and attack helicopter are not competitive antiarmor weapons systems in that neither system affords a marked advantage over the other.

2. The main battle tank and attack helicopter are highly compatible weapons systems that are best employed using offensive principles where their mobility, firepower, and survivability can be optimized.

3. The bi-dimensional mobility capabilities and overlapping firepower characteristics of the main battle tank and attack helicopter are desirable and enhance the ability to achieve a favorable exchange ratio on the battlefield.

4. The main battle tank, complemented by the attack helicopter, will remain a decisive antiarmor weapons system for the foreseeable future.

Thus, the first country to effectively integrate the attack helicopter with the tank will magnify its qualitative advantage manyfold.[3] On the one hand, the attack helicopter's mobility and long range striking power will provide the means, like the light cavalry of the past, to take advantage of faults in the enemy attack and to come quickly to the aid of troubled sectors of the friendly defense.[4] On the other hand, the main battle tank's ballistic protection and effectiveness of fires at close distances will enhance

the destruction of the enemy in that the greatest percentage of tank engagements are fought at short ranges. Lastly, the combination, rather than the elimination of these two systems will produce among the enemy the shock effect of bi-dimensional engagement. This factor will serve to increase the chances for success against numerically superior forces because "every man/weapon system is first and foremost a function of the man operator and can be severely limited by the performance of that man's mind in a most unnatural environment."[5]

RECOMMENDATIONS

1. That FMs 17-1 and 17-15 be updated to reconcile the question of primacy by doctrinally affirming that the combined employment of the main battle tank and attack helicopter constitutes the best defense against tanks.

2. That the main battle tank and attack helicopter be developed as dual, but compatible armor-defeating weapons systems.

3. That additional studies and tests be conducted to develop tactics and doctrine in order to optimize the complementary capabilities of the main battle tank and attack helicopter.

CHAPTER V

FOOTNOTES

1. Major L. Wayne Kleinstiver, "The Archipelago Defense," Infantry, March-April 1974, p. 27.

2. Wing Commander T.S.C. Jones, AFC, RAF, "The Attack Helicopter in Close Support," The Royal Air Force Quarterly, Vol. 13, No. 2 (Summer 1973), p. 127.

3. Philip J. Murphy, "Thesis on Future Military Design — A Forecast of Combat Vehicle Systems," Technical Report No. 11737, Mobility Systems Laboratory, U.S. Army Tank Automotive Command, Warren, Michigan, January 1973, p. 13.

4. Ibid.

5. Murphy, op. cit., p. 21.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Halperin, Morton H. Defense Strategies for the Seventies. Boston: Little, Brown and Co., 1971

Kaplan, Abraham. The Conduct of Inquiry. Scranton, Pennsylvania: Chandler Publishing Co., 1964.

McKechnie, Jean L. (ed.). Webster's New Twentieth Century Dictionary, Unabridged, Second Edition. New York: The Publishers Guild, 1961.

Mackey, Kenneth and John H. Batchelor. Tank: A History of the Armored Fighting Vehicle. New York: Ballantine Books, 1971.

Seitz, Frederick and Rodney W. Nichols. Research and Development and the Prospects for International Security. New York: Crane, Russak, and Co., 1973.

Sidorenko, A.A. The Offensive (A Soviet View). Moscow: 1970.

Articles and Periodicals

Bray, Major General Leslie W. "Tactical Counterforce." Air Force Magazine, June 1974.

Brower, Kenneth S. "Armor in the October War." Armor, May-June 1974.

Cohen, Captain R.J., Canadian Land Forces. "Helicopter - Panacea or Pipedream?" The Army Quarterly and Defense Journal, July 1973.

Dunetz, Bryant A. "Tank Gun or Missile." Armor, March-April 1973.

Dunetz, Bryant A. and Dr. Ceslovas Masaitis. "Mobility and Survival." National Defense, January-February 1975.

Etterlin, Colonel Dr. F.M. von Singer und. "Operational Mobility - A Function of Design." Armor, January-February 1970.

Hanby, Colonel John B., Jr. "Hellfire." Aviation Digest, January 1975.

Howze, General Hamilton H. "Tactical Employment of the Air Assault Division." Army, 1963.

Huettel, Major I.G. Rolf A., Deutsch Bundeswehr. "Defense Against Armor in the German Army." Armor, September-October 1970.

Isenhower, Captain James P., Jr. "NOE-Survival Altitude." Infantry, November-December 1973.

Jones, Wing Commander T.S.C., AFC, RAF. "The Attack Helicopter in Close Support." The Royal Air Force Quarterly, XIII, No. 2 1973.

Kleinstiver, Major L. Wayne. "The Archipelago Defense." Infantry, March-April 1974.

Ludvigren, Eric C. "Army Weapons and Equipment 1973: The Tyranny of Rising Costs." Army, October 1973.

Maddox, Major General William J. "Where We Are--Where We Are Going." Aviation Digest, November 1974.

Merritt, Jack N. and Pierre M. Sprey. "Quality, Quantity, or Training." USAF Fighter Review, Reproduced in USACGSC Instructional Publication M3121-12, 1974.

Miley, Henry A., Jr. "Cost is the Arbiter in Weapons Design." Army, October 1973.

Ogorkiewicz, Richard M. "Antitank Weapons." Armor, May-June 1973.

Palmer, General Bruce, Jr. "Army Aviator of the Year." Army Aviation, 31 December 1971.

Putnam, Lieutenant Colonel Carl M. "Proponency of Aerial Fighting Vehicles." Armor, May-June 1970.

Shackleton, Major N.A., Lord Strathcona's Horse (Royal Canadians). "Will the Tank Go the Way of the Horse?" Armor, September-October 1968.

Simulation Publications. Strategy and Tactics, June-July 1974.

Starry, Major General Donn A. "Observations of the Tank-Antitank Battlefield." Armor, January-February 1974.

Staudt, Honorable Herman R. "The Army Looks Ahead." National Defense, September-October 1974.

Talbott, Major General Orwin C. "Gun or Missile?" Infantry, March-April 1973.

Tarpley, Major General Thomas M. "Airmobility in Mid-Intensity Warfare." Aviation Digest, July 1974.

Williams, Lieutenant General Robert R. "A Time for Transition." Army Aviation, XX, 31 December 1971.

Adams, H.E., J.A. Bruner, R.E. Forrester and D.M. Lester. "Carmonette Air-Mounted Antitank System Effectiveness." Maryland: Research Analysis Corporation, July 1962.

Annual Defense Department Report FY 1974. Washington: Government Printing Office, 1974.

BDM Services Company. Tactical Helicopter Employment Study (THES). Volumes I-VIII. Monterey, California, November 1973.

Comeyne, William G. Antitank Effectiveness of the U.S. Army Standard Minefield Pattern. Fort Belvoir, Virginia: U.S. Army Mobility Equipment Research and Development Center, April 1970.

"Defense Budget for 1974." Commanders Digest, March 15, 1973.

"Defense Dudget FY-75." Commanders Digest, March 7, 1974.

Eckles, Andrew J., III. "A Human Factors Review of Tactical Mobility-Combat Agility for the M60 Series Tank." Aberdeen Proving Ground, Maryland: Human Engineering Laboratory, Notes 8-72, June 1972.

Faugere, H., Soldati, et al. "French Views of French and West German Armored Vehicles." Washington: U.S. Army Foreign Science and Technology Center, December 1970.

Fernstrom, Robert W., Jr., et.al. "Cross Country Speed and Driver Vibrational Environment of the M60 Main Battle Tank." Aberdeen Proving Ground, Maryland: Human Engineering Laboratories, Technical Memorandum 7-65, July 1965.

Fisher, K.W. "Mobility Evaluation of Vehicle Types." Aberdeen Proving Ground, Maryland: Ballistic Research Laboratories, Technical Note No. 1543, July 1964.

FM 17-1. Armor Operations. Headquarters, Department of the Army, October 1966.

FM 17-15. Tank Units Platoon, Company, and Battalion. Headquarters, Department of the Army, March 1966.

FM 23-3. Tactics, Techniques and Concepts of Antiarmor Warfare. Headquarters, Department of the Army, August 1972.

Goulet, B.N. "Methods Used at U.S. Ballistic Research Laboratories for Evaluation of Tanks and Antitank Weapons in the Antitank Role." Aberdeen Proving Ground, Maryland: Ballistic Research Laboratories, Memorandum Report No. 1455, March 1963.

Headquarters Joint Evaluation Group. "Joint Attack Helicopter Instrumented Evaluation -- Preliminary USAREUR Report -- Phase IV." June 1972.

Jacobson, William H., Jr. "Reliability Analysis of the M60 Main

Battle Tank and the M151 ¼ Ton Utility Truck from Operating and Maintenance Data." Virginia: Research Analysis Corporation, Technical Paper RAC-TP-212, March 1966.

Kostiak, Harry and Wallace R. Harris. "A Cost Effectiveness Analysis of the SS-11B1/UH-1B Weapon System." Aberdeen Proving Ground, Maryland: Ballistic Research Laboratories, Memorandum Report No. 1470, August 1963.

MASSTER Test No. 151. "Attack Helicopter Squadron Test Report Executive Summary." Fort Hood, Texas, July 1973.

Murphy, Philip J. "Thesis on Future Military Design -- A Forecast of Combat Vehicle Systems." Warren, Michigan: U.S. Army Tank Automotive Command, Technical Report No. 11737, January 1973.

Putnam, J.L., F.W. Cleaver and J.M. Owen. "Application of Trade-Off Methods to Armored Vehicle Design Evaluation," Ford Motor Company, Aeronutronic Division, Publication No. S-2279, 25 September 1963.

Rula, A.A., C.A. Blackman, et al. "Relative Off-Road Mobility of MBT70 and M60A1E1 Tanks in Selected Terrain in West Germany." Vicksburg, Mississippi: U.S. Army Engineer Waterways Experimental Station, Technical Report M-70-10, July 1970.

Tolson, Lieutenant General John J. Airmobility 1961-1971. Washington: Department of the Army, 1973.

U.S. Army Armor School. Comparative Characteristics of Main Battle Tanks. Fort Knox, Kentucky, June 1973.

U.S. Army Armor School Combat and Training Developments Training Text 17-37-9 (2d printing) "Ground Commanders Guide to Employment of Attack Helicopters and Air Cavalry Units." Fort Knox, Kentucky.

U.S. Army Combat Developments Command. "K" Tank. AIN 7356, July 1969.

U.S. Army Combat Developments Command. "MBTTF Support Study: An Examination of MBT/AAH Relationship." July 1972.

U.S. Army Combat Developments Experimental Command. "Attack Helicopter Daylight Defense." Experiment 436.

U.S. Army Foreign Service and Technology Center. Stop the Tanks (Country: Czechoslovakia). Washington: November 1969.

U.S. Army Infantry School. Antiarmor Tactics and Techniques for Mechanized Infantry.ST 23-3-1. Fort Benning, Georgia: 1974.

U.S. Army Training and Doctrine Command. "Range and Lethality of U.S. Soviet Antiarmor Weapons." TRADOC Bulletin 1, September 1974.

Unpublished Material

Masterson, Colonel Joseph H. "The Aerial Vehicle: A Technological Threat to Armored Warfare." USAWC Research Paper, 28 February 1972.

U.S. Army Aviation Center, "U.S. Army Aviation Tactical Doctrine, Techniques, and Training for Survival in a Mid-intensity Combat Environment." Special Working Party for Aircraft Survivability in the Battlefield Environment. Fort Rucker, Alabama: March 1974.

U.S. Army Command and General Staff College. Appendix A, FM 100-5 (Test) (Draft) April 1975.

U.S. Army Command and General Staff College. Selected Readings for Antiarmor Operations. RB 100-6. Fort Leavenworth, Kansas; September 1974.

U.S. Army Command and General Staff College. Selected Readings in Tactics." RB 100-2 Volumes I, II, III and Chg. 1 to Volume I. Fort Leavenworth, Kansas: 1974.

Vamvakias, Major Nicholas P. "An Analysis of the Russian Armor Threat Facing U.S. Forces in Central Europe and a Determination of How to Counter this Threat During the 1971-1980 Time Perior." CGSC Student Paper, April 1971.

Youngblood, Captain George L. "The Attack Helicopter Vs Armor: A Study of Tactics and Techniques." CGSC Student Paper, April 1974.