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An Appraisal of CAS (Close Air Support) Capabilities

Volume III—A Review of Selected CAS Studies and Experiments

by William H. Jacobson
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TECHNOLOGICAL SYSTEMS GROUP CLIENT REPORT RAC-CR-72 Published December 1972

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Volume III--A Review of Selected CAS Studies and Experiments

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Volume III

A REVIEW OF SELECTED CAS STUDIES AND EXPERIMENTS

INTRODUCTION

One of the study tasks was to review selected close air support (CAS) studies and reports on CAS experiments, as an initial step in providing an inventory of the existing body of data and information on CAS operations. This volume presents this review.

PURPOSE

The purpose of the review was to describe the articles, reports, tests, and models available in the selected CAS studies and experiments so that their usefulness to the reader concerned with CAS can be readily determined. The description includes the title, source, and publication date of the material reviewed. The review consists of an unclassified statement or description of the scope and problem addressed by the material, and the methodology used or developed. The review also comments on the relevance of the work reported to the study of CAS operations, including the pertinence of the methodology employed or developed.

SCOPE

The studies reviewed include the existing body of data and information published by the Joint Technical Coordination Group on Munitions Effectiveness concerning air-delivered weapons in CAS operations and the existing methodologies and analytical procedures that have been developed or used to establish Army requirements. Although studies and experiments bearing on CAS operations have been emphasized, other studies that may provide methodological and procedural insight into CAS have also been included.

REVIEW APPROACH

The review format provides a brief statement of the scope of each study and the problem analyzed. The methodological approach and techniques, and the relevance of the study to the elements listed below are also included. Eleven study elements were used in the review as a common basis of evaluation:

1. Military Situation - Discussion and estimates of typical tactical situations that emphasize problem areas and operational context.

2. Target Analysis - Estimation of target compositions and vulnerabilities.

3. Threat Analysis - Estimation of the enemy capabilities to perform military operations.

4. Technological Forecast - Prediction of the requirement for operational equipment, including future improvements.

5. Weapon System Characteristics and Performance - Descriptions of weapon systems and their capabilities.

6. Weapon System Analysis - Comments and test results concerning effectiveness.

7. Comparative Analysis - Relative capabilities of weapon systems to perform specific tasks.

8. Cost Effectiveness - Cost of alternative weapon systems performing equivalent tasks (or measure of tasks that can be performed at equal costs).

9. Resource Implications - Estimation of the resources -- in manpower, costs, scarce items, etc. -- to permit comparison of alternatives.

10. Alternative Force Structure - Determination of the number and type of units in force structure to meet the objectives of a commitment.

11. Optimum Force Mix - Appraisal of the consequences of adapting each force structure alternative in terms of resources and mission performance.

A summary of the studies and experiments reviewed is presented in Table 1. The table shows which study elements are addressed in each of the publications. To be listed the treatment has not necessarily been considered to be comprehensive nor focused on the most important aspects of the study element. The individual reviews discuss, in general

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TABLE 1

Publication Review Summary[a]

Publications	Study elements										
	Military situation	Target analysis	Threat analysis	Technological forecast	Weapon system characteristics and performance	Weapon system analysis	Comparative analysis	Cost effectiveness	Resource implications	Alternative force structure	Optimum force mix
1. "Estimates of Close Air Support Weapons Effectiveness and Aircraft Survivability"					P	S					
2. "Joint Munitions Effectiveness Manual" publication series (JMEM)		S	S		P						
3. FASTVAL Study documents	P	P	S		P	P	P				
4. Air Mobility in the Mid/High-Intensity Environment (AM/HI) Study	P	S	S		P		P				
5. Documentation of ADAFSS force mix analysis	S	S	S		S	S	P	S	S	P	P
6. Packard Report on close air support	S	S	S		P		P	P			
7. USACDCEC Test 43.5							P				
8. USACDCEC Test 43.6					S	S	P				
9. Air cavalry troop evaluation	S				P	P	P			S	S
10. Joint AH-1G (Cobra) follow-on evaluation	S		S		P	P	S			S	S
11. "Value of Fire Support and Fire Support Systems"	P	P	S	S	P	P	P	P	S	S	
12. Technical support for the Tactical Warfare Research Advisory Committee (TACRAC) Program		P	S		P	P	S				
13. Theater Battle Model (TBM-68)	P	S	S				P				
14. "A Methodology for Determining Support Weapon System Mixes"							P	P	S	S	P
15. "Cost-Effectiveness Comparison of Artillery Systems for Support of Airmobile Operations"		S		S	S	P	P	P	S		
16. Final report on impact of semi-active laser guidance	S		S	S	P	P	P				

[a]Emphasis code: P, primary; S, secondary.

terms, the degree of completeness of each study element shown in Table 1.

PUBLICATION REVIEWS

The reviews in this volume are presented in Attachments 1 through 16. Each is divided into the following sections: Scope; Problem; Methodology; and Relevance.

Attachment 1

Title: "Estimates of Close Air Support Weapons Effectiveness and Aircraft Survivability"[1]

Source: Joint Technical Coordinating Group For Munitions Effectiveness (JTCG/ME)

Date: 30 September 1971

SCOPE

The close air support weapon effectiveness and aircraft survivability estimates presented in this technical report were developed by the JTCG/ME at the request of the Assistant Director for Defense Research and Engineering for Land Warfare (DDR&E) and the Government Accounting Office (GAO). The weapons effectiveness portion of the report concentrates primarily on delivery accuracy, tank vulnerability and munitions lethality. However, it only partially addresses the opportunity for employing weapons in the real-world environment. Intervisibility (near ground applications) and daytime visibility (elevations significantly above ground) probabilities are presented to indicate the fraction of time a target has a chance of being detected. Opportunity and target acquisition per se are not considered.

The aircraft portions of the report consider primarily accuracy of fire, aircraft vulnerability and AA lethality. Factors affecting the opportunity to use AA weapons against attacking aircraft like weather, sensor-target intervisibility, probability of acquisition given sensor-target intervisibility, reaction times, firing doctrine, multiple aircraft targets and AA suppression measures are addressed to a limited extent.

PROBLEM

A source of joint service approved effectiveness data on selected weapons used by current and planned close air support aircraft is

required for close air support studies. Although much of the required information was assumed initially to be available from prior studies, additional data had to be developed. The report objective is to provide "within a single document the most important known or simplistic measures of close air support anti-tank effectivity and simplistic estimates of aircraft survivability."

METHODOLOGY

Effectivity estimates were prepared versus the T-55 tank for TOW, MAVERICK, ROCKEYE II and various 30 mm cannons, including the USAF GAU-8, the Army XM-140 (WECOM 30mm), the Oerlikon 304RK and the DEFA/Aden. Survivability analyses were carried out for the A-4M, A-7D/E, AV-8 Harrier, F-4E, A-X, AH-1G Cobra and the AH-56A Cheyenne exposed to mid-intensity defensive weapons such as 23mm and 57mm guns.

RELEVANCE

This report was prepared specifically for use in close air support studies to provide an authoritative source for technical data estimates of weapon effectiveness and aircraft survivability. The report is limited to information on weapon systems characteristics and performance data and some weapon system analysis results. Tests and analyses required to fill in serious data deficiencies are enumerated.

Weapon System Characteristics and Performance

This report compiles the latest technical information on some of the important close air support weapon system characteristics and performance.

Weapon Systems Analysis

Limited analysis was performed to provide weapon effectiveness and aircraft survivability data. The areas covered were Heliborne TOW employment; MAVERICK seeker lock-on-times and ranges; selective feed for 30mm AF gun; aircraft vulnerability estimates; aircraft attrition estimates; and friendly troop safety.

Attachment 2

Title: Joint Munitions Effectiveness Manual Publication Series (JMEM) [2]

Source: Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME)

Date: Continuing Update

SCOPE

Information in the JMEM publication series concerns weapons effectiveness, selection and requirements. Emphasis in the series is placed on weapons currently available, but information is included on some weapons projected for the near future. In the JMEM publication, the closely related fields of weapon characteristics and effects, target characteristics, and vulnerability are treated in the limited detail required by the strike planner. Other publications by JTCG contain more detail concerning the various phases of weapon effectiveness calculations and weapons selection and requirements.

PROBLEM

To provide a comprehensive, single source of information covering weapons effectiveness, selection and requirements.

METHODOLOGY

The various weapons effectiveness problems that were encountered are categorized; the types of weapons considered effective against a spectrum of targets are indicated; the analytical procedures for obtaining solutions to the various munitions problems are discussed; and several other factors pertinent to the computation of effectiveness of the various weapons are given.

RELEVANCE

The JMEM series, directed primarily to the strike planner, contains an abundance of figures and tabular data. It is a useful source for target and weapon system characteristics and performance data

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for CAS studies. However, more up-to-date and relevant data is often available in other JTCG publications.

Target and Threat Analysis

Target characteristics, performance, and vulnerability data that could be useful in CAS studies are present in the JMEM.

Weapon System Characteristics and Performance

The JMEM presents information on detailed weapon characteristics and weapon system performance against a wide range of standardized target characteristics.

Attachment 3

Title: FASTVAL Study Documents [3]

Source: RAND

Date: Continuing Study (approximately 75 published documents)

SCOPE

FASTVAL, a Forward Air STrike EVALuation Model, is a computer model developed for the Air Force that is undergoing continuing evolutionary development. The model is used to assess the effects of various conventional weapons on ground combat operations. Early studies of this on-going program evaluated only the contribution of air-delivered weapons. Later studies were expanded to also evaluate ground-delivered weapons in ground combat operations. The model is applicable for use in dynamic war games or with static target arrays and the model results have been verified by detailed comparisons with actual fire fights in Vietnam. The model quantitativity accounts for delivery accuracy, target vulnerabilities, effects on targets other than the ones aimed at, postures of troops, rates of advance as affected by casualties, suppression of fire, and other detailed effects.

PROBLEM

The various interacting facets of ground combat and close air support have posed a requirement for detailed modeling and computation. The FASTVAL model was developed to assess the effect of both ground weapons effects and close air support on ground combat operations. The model objective is to provide a consistent and flexible method for accommodating present and future weapon characteristics and tactical employment concepts, and to evaluate the input of terrain and target force deployment in present and future studies.

METHODOLOGY

The model simulates military situations in which ground forces are engaged and reserves are deployed. The area coverage can range from the FEBA back to corps or division headquarters. The number of men, mortars, machine guns, artillery pieces, supplies, and trucks in each 100-foot grid square are determined from deployment information identified in snapshots or during a series of intervals. The procedure permits statistical indices to be constructed for assessment of the target system as a whole. Initially Army firepower scores were used as a measure or index of the importance of the elements under air attack. However, the model has been developed to use other measures. More detailed simulations of smaller unit actions involving movement of the ground force as affected by enemy fire, suppression effects, and casualties, can be simulated.

RELEVANCE

The FASTVAL documentation treats the effects on ground forces of close air support, other air attacks, and ground unit fires. In general these studies do not consider aircraft attrition, the quantities of aircraft needed to create the effects, nor the aircraft facilities and logistic support required to accomplish the missions.

Military Situations

The model has been used for offensive and defensive situations for units from company size to regiments. Ground forces have been studied in Europe, Korea, and Southeast Asia. Although this model is not limited to the evaluation of CAS operations, it has been used to evaluate the contribution of air strikes in a number of situations that would normally be identified as CAS missions.

Target Analyses

The FASTVAL models provide a highly detailed and complete analysis of the effects of a broad range of ground- or air-delivered weapons on the capabilities of a large variety of specified ground units. The early analyses concerned snapshots either on a target array or war game basis. Later analyses have dealt with movement over time (in 4-second increments) of smaller forces (i.e., companies).

Threat Analysis

The FASTVAL analyses have concentrated on the evaluation of ground combat force structures employing present and future weapon systems. However, these analyses have not treated the overall aspects of the threat to CAS operations.

Weapon Characteristics and Performance

Weapon effects applicable to CAS operations as they impact on ground forces are treated comprehensively and in detail.

Weapon System Analysis

The model provides detailed comparisons of different weapons systems effects on air strike effectiveness. The FASTVAL documents perform a detailed analysis of weapons effects. However, the capability to satisfactorily deliver the weapons is assumed. The studies do not include the logistics or vulnerability problems of getting the air vehicles into a position to deliver the armament.

Comparative Analysis

These studies have concentrated on the comparative effect of alternative weapon systems against ground forces.

Attachment 4

Title: Air Mobility in the Mid/High-Intensity Environment (AM/HI) Study[4]

Source: USACDC, Institute of Special Studies

Date: January 1971

SCOPE

The AM/HI study evaluates air mobile operations in mid/high-intensity warfare in Europe. It contains results concerning helicopter vulnerability/survivability. The study also assesses the use of attack helicopters to counter enemy armor in an air mobile context.

PROBLEM

The AM/HI study was conducted to develop justification for aviation requirements in the combat structure of the Army for the 1970-75 time period.

METHODOLOGY

Part I of the AM/HI study uses the results of a specially developed computer model (called EVADE II) to study the vulnerability of attack helicopters, with emphasis on terrain. Lines-of-sight are calculated between helicopters and their targets, and between enemy ground weapons and the helicopters as a target. The terrain data used are for an area of Germany providing a variety of typical line-of-sight problems. The vulnerability information is used as inputs to the other parts of the AM/HI study, which make use of war games and other analysis techniques.

RELEVANCE

Although the AM/HI study was focused on air mobile operations, the vulnerability/survivability model (developed by AMSAA) is particularly pertinent to the analysis of helicopter attrition in CAS studies. The EVADE II model is designed for nap-of-the-earth flight computations; therefore, it is not applicable to fixed-wing vulnerability/survivability evaluation.

Military Situations

The AM/HI study emphasizes penetration by air mobile forces. It also investigates the vulnerability of attack helicopters employed behind a FEBA. Enemy postures of attack and withdrawal are studied. The high vulnerability of helicopters employed over enemy terrain in a high-intensity conflict is shown.

Target Analyses

Soviet troop dispositions are studied from the point of view of possible helicopter penetrations, but no study of fixed-wing penetrations was made.

Threat Analysis

Details of Soviet defensive capability were studied and are presented in the study.

Weapon Characteristics and Performance

Information on effectiveness of various helicopter-carried weapons was gathered and organized into gaming models. For studies of CAS operations, these are of limited direct value.

Comparative Analysis

The vulnerability sections of the AM/HI study provide comparisons concerning various possible helicopter tactics, including vulnerability during nap-of-the-earth flying over enemy territory, and during pop-up maneuvers for firing TOW missiles from behind a FEBA. No fixed-wing vulnerability information is given.

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Attachment 5

Title: Documentation of Incomplete ADAFSS Force Mix Analysis [5]

Source: Research Analysis Corporation

Date: 1 January 1972

SCOPE

The study was undertaken to develop and employ a methodology for determining the number and type of attack helicopters to be included in the 1975-80 force structure of the US Army. Attention was to be concentrated on the preferred mix for the division in mid-intensity conflict in Europe. The methodology was developed, but employed only minimally because of a curtailment of funding. The preferred mix was, therefore, not derived, but some observations pertinent to CAS were offered.

PROBLEM

The problem addressed in this study was threefold (with emphasis on Part 1): (1) to determine the most efficient mix of attack helicopters by number and type, required for support of the US Army in mid-intensity conflict in Europe in 1975-80; (2) to recommend a program for phasing this mix into the Army inventory consistent with production rates, funding levels, and current assets; and (3) to do a trade-off analysis of attack helicopters versus other fire support systems.

METHODOLOGY

War games performed in the past were examined to provide descriptions of typical scenarios and missions which were best suited for employment of attack helicopters. The data was adapted to a 60-day period of extended combat in the timeframe of concern. An evaluation model was developed and tested to examine the performance of selected mixes of equal cost fleets under these conditions. Considerable effort was also devoted to reviewing previously performed study efforts. Their results and applicability to the ADAFSS study were summarized.

RELEVANCE

Only one-third of the project was completed due to curtailment of funding. The authors claim to have achieved no significant results, but do have some appropriate observations to offer.

Military Situation, Target Analysis, and Threat Analysis

Available information was outlined. Existing war game data was used to assess mission requirements for mid-intensity levels. This information is presented in tabular form.

Weapon Systems Characteristics, Performance, and Analysis

Literature was reviewed and data presented on the performance of 2.75-in FFAR as an antiarmor weapon. Detection and engagement range capabilities of both air defense and helicopter team systems were surveyed. The capabilities of weapons other then the FFAR were not given.

Comparative Analysis

An evaluation model was developed and described. The model was used with preliminary data and outputed expected exchange ratios. The results were inordinately favorable to the friendly forces, probably because excessive detection and engagement ranges were assumed.

CDCED data was also presented comparing performance of various basic attack helicopter teams. The teams were composed of different ratios of scout and attack helicopters.

Cost Effectiveness and Resource Implications

Data are presented comparing the costs of using helicopters and other type weapons for preparatory fire missions. The example presented represented about 6% of the possible different uses of these systems.

Alternative Force Structure and Optimum Force Mix

Candidate fleet mixes based on equal cost were generated. Attrition was not factored in. The objective was to maximize effectiveness within budgetary and procurement constraints. This data was inputed to the evaluation model and effectiveness was measured by the ratio of armored vehicles killed to total replacement cost of aircraft lost. Typical results are given, along with warnings as to the incompleteness and preliminary nature of the work.

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Attachment 6

Title: Packard Study on Close Air Support[6]
Source: Deputy Secretary of Defense
Date: June 1971

SCOPE

The study was to determine the requirements for close air support (CAS) in the late 1970s and to assess the capabilities of current and projected CAS systems to meet those requirements. Roles and missions were subordinated to issues of: complexity; aircraft merit; uncertainties to be resolved; and the further work required to enable procurement decisions. The designated theaters of interest were Europe, Korea, and the Middle East.

PROBLEM

Each of the Services was pursuing its own approach to providing CAS. The purpose of the Packard study was to perform a joint analysis of close air support requirements to provide guidance as to the most appropriate development and procurement policies to be followed.

METHODOLOGY

Requirements were defined through development of three typical scenarios (Europe, Middle East, and Korea). The current inventory was examined, shortcomings pointed out, and estimates made of the projected capability of current, improved, and new CAS systems to perform required missions.

RELEVANCE

The entire study is devoted to an evaluation of CAS problems and potential solutions. It also points out areas of uncertainty and recommends tests for their resolution.

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Military Situations, Target Analysis, and Threat Analysis

The scenarios for typical combat situations were developed in reasonable detail with tabulated listings and mapped locations of the assumed threat. A review of the history of CAS was also provided.

Weapon System Characteristics and Performance

A technical review of the characteristics and performance of current, modified, and future CAS systems was conducted. Topics such as payload (weight and type) versus radius of action, take-off distance, loiter time versus distance to target, sortie rates, maneuverability, delivery accuracy, vulnerability, and cost were presented. Laser-guided bomb performance and test results were also reported.

Comparative Analysis and Cost Effectiveness

Comparisons and analysis were made of helicopter and fixed-wing aircraft losses in Southeast Asia. Finally, with all factors considered, evaluations of system effectiveness on a cost basis were performed comparing alternative Air Force aircraft, Cheyenne versus AH-1G, Harrier versus A-4, and Army versus Air Force close air support aircraft. The latter evaluation was limited to presentation of comparative data rather than firm concluding statements.

Attachment 7

Title: USA CDCEC Test 43.5 [7,8,9]

Source: Research Analysis Corporation

Date: 1 January 1972

SCOPE

This test report compares the target detection and engagement capabilities of various combinations of light observation helicopters (LOHs) and attack helicopters (AHs), with TOWs, in terrain similar to that of Central Europe. Three RAC documents that contain analyses of the reported results were the source of the present review.

PROBLEM

To determine the performance differences between various combinations of LOHs and AHs with the AHs attempting to launch TOWs from near maximum range at ground targets whose locations had been predetermined by ground or aerial observers.

METHODOLOGY

The tactical concept was to use a nap-of-the-earth (NOE) approach, pop-up outside of maximum TOW range, find the target, drop down, relocate at maximum TOW range, pop-up, reacquire, and fire. The targets consisted of columns of tanks, antiaircraft weapons, and armored personnel carriers. Records were kept of who detected whom first, who fired first, and the consequent calculated exchange ratio.

RELEVANCE

The RAC analysis reviewed here addressed the evaluation of CDCEC Test 43.5 results.

Weapon System Characteristics and Performance, and Comparative Analysis

Basic helicopter target acquisition and attack performance data are presented in CDCEC Test 43.5 results. The RAC analysis of these test results points out the difficulty in drawing conclusions regarding

performance comparisons between various combinations of LOHs and AHs in close air support. It also compares the CDCEC results with other tests and suggests navigation-related reasons for the anomalous results seen at CDCEC. The material presented in the CDCEC Test 43.6 and in the RAC analysis of it are especially relevant to CAS studies.

Attachment 8

Title: USA CDCEC Test 43.6[10,11,12]

Source: Research Analysis Corporation

Date: 24 May 1972

SCOPE

The previously run CDCEC test 43.5 had resulted in unexpectedly short detection and engagement ranges. This test, 43.6, was to investigate new tactical techniques and visual aid systems to determine if these ranges could be improved. This review combines the RAC findings[10] and a review of the two referenced CDC documents.[11 & 12]

PROBLEM

To examine the effects on detection and engagement ranges of improved training, tactics, and visual aids with teams of 1 LOH and 2 AHs.

METHODOLOGY

The experiment was conducted in four phases:

Phase I: Different tactics were attempted to increase the engagement range.

Phase II: Using the best tactics from Phase I, performance measurement using laser realtime casualty-assessment was attempted. First, detections and ranges of engagement were determined.

Phase III: Different optical sighting systems were assessed at a variety of ranges to see what effect they might have on range of engagement.

Phase IV: AH-56A is being compared with AH-1G, but results are not yet available.

RELEVANCE

The RAC analysis addressed the evaluation of CDCEC 43.6 test results.

Weapon System Characteristics, Performance, and Analysis

Recommendations were made regarding search mode, determination of firing position, and optical techniques for detection and identification.

First detections, first firing, and engagement ranges achieved by the air and ground systems were reported. Uncertainties in the validity of The results attributable to faulty operation of the casualty assessment system and inoperability of one of the two air defense systems are discussed. Data were also presented on the times required for detection, exposure times, and exchange ratios at several ranges using several visual aid systems.

Comparative Analysis

The revised tactics of CDCEC test 43.6 were compared with those of 43.5 and detection and engagement performance noted. Various visual aid systems were also compared at different ranges for their effect on target engagement range. Exposure time at the different ranges was also noted.

Attachment 9

Title: Air Cavalry Troop Evaluation[13]

Source: USAREUR and Seventh Army

Date: July 1970

SCOPE

The investigation was to cover the gamut of air cavalry missions and capabilities in the European theater in early spring.

PROBLEM

A twofold problem was addressed: (1) determination of air cavalry missions compatible with the European environment and assessment of tactics and techniques for accomplishing them, and (2) determination of the suitability of the applicable TOE (17-108G) for the accomplishment of the missions.

METHODOLOGY

The program was in four phases: (I) organization of the evaluation group and development of the evaluation plan, (II) reorganization of the test unit according to the TOE, (III) acquisition of necessary equipment and determination and performance of necessary training, and (IV) the field evaluation, consisting of the collection and analysis of data.

RELEVANCE

Most of the air cavalry missions and experience described in the study bear on the CAS function.

Military Situation

A military situation is described for the entire schedule of events for Phase IV. Type of activities, weapon systems employed, scenarios, and stand-down time are broken out.

Weapon System Characteristics, Performance, and Analysis

Information is provided on helicopter operating data (OH-58A, UH-1B, and UH-1D) and on the results of live firing tests. Detailed

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acquisition and engagement data are reported and analyzed. Performance in adverse weather and in night operations is also reported on. Basing and logistic problems are discussed from the survivability and operations standpoint.

Comparative Analysis

Four modes of employment of light helicopters were compared: singly and in pairs, with and without observers, at nap-of-the-earth and tree-top levels, and with pop-up versus dismounted observers.

Four methods of employing heavy (armed) scouts were compared: singly and in pairs, with and without door gunners, with and without light scout, and firing missiles from hover versus from forward flight. Various attack patterns were also compared. Adverse weather capabilities of helicopters and fixed-wing aircraft are discussed.

Alternative Force Structure and Optimum Force Mix

Recommendations concerning the composition and TOE of the Air Cavalry troop are offered.

Attachment 10

Title: Joint AH-1G (Cobra) Follow-on Evaluation [14]

Source: USAREUR and Seventh Army

Date: January 1971

SCOPE

A comparison of the AH-1G and the UH-1B in the air cavalry role in Europe plus an evaluation of other related acquisition, weapon, and defense systems.

PROBLEM

A twofold problem was addressed: (1) determination of any increase in combat effectiveness through introduction of the AH-1G attack helicopter, and (2) determination of changes required in TOE 17-108G to accommodate the AH-1G.

METHODOLOGY

The program was conducted by first developing an evaluation plan, then procuring the necessary equipment and performing the required training, and finally, performing the field evaluation, including collection and analysis of data. There was German and Canadian participation.

RELEVANCE

The whole study was integrally related to the performance of close air support, treating among its subjects the air defense threat, concealment of ground-based helicopters, effectiveness of FLIR-equipped helicopters, and the comparative performance of AH-1Gs and UH-1Bs. The report points out that ideal, non-typical weather prevailed during the tests, conducted in the summer. Caution should be used in that many of the results might not be typical.

Military Situation

A military situation is described for the entire field evaluation in terms of time, action, and performing agent.

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Threat Analysis

The disposition and use of Chaparral, Vulcan, and Redeye air defense weapons representing the threat is described and analyzed. Unclassified data on the systems is presented. Weapons effectiveness against helicopters is reported.

Weapon Systems Characteristics, Performance, and Analysis

A description of the AH-1G and its armament is presented. Some unclassified data on TOW is also shown. Detailed acquisition and engagement data is reported and analyzed. The contributions of FLIR to nighttime performance are reported, as is its bad-weather operation. Discussions were included concerning camouflage and concealment of ground-based helicopters.

Comparative Analysis

Most of the missions conducted by AH-1Gs during this follow-on evaluation in the summer are not directly comparable in outcome to those conducted by UH-1Bs in early spring because of large differences in weather, in the assumed level of activity of the enemy ground elements, and in the techniques of employment. However, a comparison is made based on their technical characteristics.

Alternative Force Structure and Optimum Force Mix

Recommendations concerning the composition and TOE of the Air Cavalry troop using an AH-1G are offered.

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Attachment 11

Title: Va... of Fire Support and Fire Support Systems [15]

Source: Research Analysis Corporation

Date: May 1971

SCOPE

This analysis of fire support and fire support systems in ground combat was performed by RAC for the Advanced Research Projects Agency, Department of Defense, and for ODDR&E (Land Warfare). The objectives of the study are: (1) to provide information on the value of ground-based and airborne fire support in all phases of ground combat operations; (2) to assess the improvements in performance to be realized by incorporating technological advances and new concepts into the fire support functions; and (3) to provide technical support on specific fire support problem of special interest and importance to the client.

The study examines the value and effect of classes of fires delivered by ground-based systems (Army), close air support (primarily Air Force), and direct aerial fire support (primarily Army) in the 1975-90 time period.

The three specific types of results developed were concerned with the contribution of fire support, the preferred characteristics of each class of fire support, and the overall capability desired from a mix of fire support systems.

The sensitivity of the study results to variations in the military situation, level and type of threat, target nature and composition, physical environment, air defense and countermeasures is assessed. The sensitivity of the results to investment and O&M costs is also addressed.

PROBLEM

To clarify major fire support issues and identify the best fire support alternatives in each phase of the ground operation.

METHODOLOGY

The products of this study are developed from two procedures. The first formal procedure involves a logical consideration of the impact of threat, military operations, and tasks to be performed on the characteristics and value of fire support systems. The second consists of an exploration and evaluation of some specific fire support systems in critical military situations by considering the means available for applying fires, the issues for consideration, a comparative analysis in the particular situation, and a sensitivity analysis.

This study considers how fire support enhances the operational effectiveness of attacking and defending forces through each of the phases of combat operations. The value of fire support and fire support systems is assessed for each of these various phases of combat. Desired capabilities for classes of fire support can be derived by considering the available targets and the functions of fire support for each phase of combat operations. Competing alternatives for fire support are suggested.

RELEVANCE

Close air support (including direct aerial fire support) was an important consideration in this study. Particularly noteworthy is the comparison of CAS as an alternative to ground-based fire support systems. Deficiencies in current fire support capability and the associated R&D options that appear to possess the greatest potential for rectifying these deficiencies are identified. Particular advantages associated with CAS/DAFS are identified in offensive as well as defensive operations. The information presented in this study is of particular relevance to CAS studies.

Military Situation, Target Analysis, and Threat Analysis

Representative military situations were described and the targets encountered in these situations were developed in detail. The threat faced by forces employing alternative fire support systems was developed as a secondary consideration.

Technological Forecast

Promising research and development areas for fire support were identified based on major current fire support deficiencies. Concepts offering promise for alleviating these current deficiencies for fire support are described.

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Weapon System Characteristics and Performance

Characteristics and performance of currently available alternative weapon systems were collected and collated. Characteristics and performance of advanced weapon systems were developed based on data projections.

Weapon Systems Analysis, Comparative Analysis, Cost-Effectiveness, Resource Implications, and Alternative Force Structure

The study emphasis is on weapon system analysis. Comparative analysis and cost-effectiveness analyses are treated as special techniques and methods used to expand and increase the completeness of the basic weapon systems analysis.

Attachment 12

Title: Technical Support for the Tactical Warfare Research Advisory Committee (TACRAC) Program, Vols I and II [16,17]

Source: Research Analysis Corporation

Date: August 1971

SCOPE

The TACRAC Symposium in February of 1971 was called to bring together military, industrial, and research leaders to discuss specified crucial military problem areas in land warfare. One of the areas discussed was close air support. Vol I presents qualitative overall descriptions of close air support problems and goals from the varied points of view of (a) the Air Force overall roles, (b) the operational environment, (c) the ground forces, (d) the Air Force delivery force teams, and (e) V/STOL applications (with emphasis on Harrier). In addition, a brief technical, quantitative overview of the problem was also presented by RAND and a transcript presented of a panel discussion concerning certain detailed areas and some general issues. Vol II, a technical support effort by the Research Analysis Corporation, contains a more quantitative exposition. It describes and analyzes the nature of the problem areas and critical issues in a thorough yet condensed manner.

PROBLEM

The purpose of these documents was to bring into perspective specified crucial problem areas for future detailed considerations by those in attendance at the symposium. Data on current and desired capabilities in various critical areas are presented in both Vol I and II, with the latter tending to be more specific.

METHODOLOGY

The presentations are descriptive, but have analytic elements. Graphic and tabular presentations are shown in Vol II on such matters as

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ranges for target acqu. ition, implications of weather, needs for CAS responsiveness, weapon accuracies and effects, weapons launch envelopes, and aircraft vulnerability.

RELEVANCE

The documents present a concise overview of areas for CAS improvements. In addition, the difficulties in achieving improvements in these problem areas are also highlighted.

Target Analysis, Threat Analysis, Weapons Characteristics, Weapons System Analysis, and Comparative Analyses

The separate presentations contained in Vol I and the results presented in Vol II deal with each of the topics listed in the head.ng. These papers present a summary overview of the need for CAS and highlights present capability and future capability.

Attachment 13

Title: Theater Battle Model (TBM-68) [18]
Source: Research Analysis Corporation
Date: January 1968

SCOPE

The Theater Battle Model is a manual that provides methods and data for evaluating planned operations, specifically those that involve the contributions of all the Services to the land battle. A spectrum of combat intensities and levels of aggregation are possible with the model. The major sections of Vol I include submodel descriptions for ground combat and combat support, air, intelligence, logistics, and nuclear and chemical-biological play. The air submodel includes the effects of close air support as part of the game results, but the CAS missions are not assessed separately. Appendices to Vol I describe the method and logic of the assessment routines for the air models.

PROBLEM

The Theater Battle Model manual is intended to provide a "valid and economic" means of evaluating plans at a level of detail low enough that the games can be played with no assist from computers.

METHODOLOGY

The game play described in TBM-68 assesses the effects of tactical air forces in a simulated theater war. Assessment of close air support missions is done by developing an aircraft "Index of Firepower Potential (IFP) Equivalent" for the tactical fighter aircraft involved. This IFP is added to the IFP of the supported ground combat units and in this way contributes to the success or failure of the ground battle. Attrition of CAS aircraft is based on "expected losses" determined during pregame preparations.

The air models aggregate many factors; e.g., they are based on average optimum armament loads for the specific type of mission and

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targets. The cycle of play is usually 24 hours, subdivided into four strike periods.

RELEVANCE

The TBM-68 manual can provide the reader with a quantitative overview of the place of CAS operations in land warfare. However, it does not show details of the operations, and the net effects are combined with the effects of ground weapons. The specifics of the CAS operation are aggregated in the final model which submerges detail, while at the same time the net effects appear to be reasonably represented.

Military Situation, Target Analysis, and Threat Analysis

The TBM-68 manual provides a methodology that can be used to examine the impact of CAS on overall war game results.

Comparative Analysis

The manual provides a vehicle for examining the war game results of a force structure having different levels of CAS support.

Attachment 14

Title: A Methodology for Determining Support Weapon System Mixes[19]

Source: Research Analysis Corporation

Date: March 1972

SCOPE

The candidate units considered for the support weapon mix structure are field artillery battalions, attack helicopter companies, and tactical fighter squadrons. The unit characteristics evaluated include capability, cost, responsiveness, and availability. Mix selection is based on a least cost, fixed effectiveness analysis in each of a large number of sequential activities. These are hypothesized to mid-intensity warfare during the conduct of both offensive and defensive operations. Each activity considers an array of opposing units from which a set of acquired targets is developed. The destruction, neutralization, or interdiction of these targets within a specified time period is taken as a fire support requirement and the accomplishment of these requirements must be achieved by the least cost mix of the candidate units.

PROBLEM

The selection of the preferred mix of units for the role of fire support from the inventory of numerous candidates with different physical, operational, and cost characteristics is a complex and continuing problem. The methodology described was developed to assist in the selection, by providing a technique for calculating mix composition based on estimates of fire support requirements and the capability of candidate units to meet these requirements.

The objective of the study was to develop a methodology to calculate the mix of fire support units which can accomplish a given set of time-dependent tasks for the least cost. Its overall purpose was to provide assistance to the Assistant Chief of Staff for Force Development,

Department of the Army, in selecting a mix of field artillery, attack helicopter, and tactical fighter units which is appropriate for the role of fire support to ground combat forces engaged in mid-intensity conflict.

METHODOLOGY

The focal point of the methodology is (a) representing fire support requirements by a set of discreet and quantifiable tasks and (b) determining capabilities of candidate fire support units to accomplish each task. Then linear programming techniques are applied to determine the least cost mix of units to fully accomplish all tasks.

The information required to apply this methodology are: (1) a target array for each activity; (2) a description of each candidate fire support unit to include its capabilities, limitations, and cost; (3) a set of acquired targets from an array, and the sequence of target acquisition; and the duration of each activity.

The methodology consists of submodels for task definition, task accomplishment, and the determination of a least cost mix.

The task definition submodels define destruction, neutralization, and interdiction tasks from the acquired target array.

The task accomplishment submodels calculate the number of units required to accomplish the specified tasks, based on unit capability and task definition data.

The mix submodel determines the mix of units to accomplish all tasks for the least cost from the data on task accomplishment, unit cost, acquisition sequence, and duration. The mix submodel also determines the mix of units used to accomplish each task and the total cost to accomplish all tasks.

RELEVANCE

The methodology is capable of calculating the least cost mix of units in accordance with the input data provided and the assumptions involved. It is a systematic process for determining the sensitivity of a solution to changes in these data and assumptions. It is useful for parametric analyses of the many variables associated with unit characteristics, costs, and operational constraints. The simplicity, low cost, and relatively high calculation speed of the mix submodel are valuable assets of the methodology and provide responsive, albeit approximate,

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solutions to fire support unit mix structure problems.

The methodology is particularly useful in determining the sensitivity of mix solutions to values assumed for such variables as unit cost, availability, responsiveness, and capability. Solutions developed in parametric form may then be incorporated into that portion of the planning process which addresses the problems of fire support mix proportions, balance, the number and type of units required, and cost.

The process can be readily recycled with new values or assumptions. For example new assumptions may be used regarding unit cost data, variations in task definition, changes in the number of candidate units, or modifications of the data/assumptions related to determining unit task accomplishment capability.

The methodology is a useful tool for assisting the force planner in obtaining better estimates of force composition and fire support capability.

Comparative Analysis

The methodology stresses the importance of initially allowing and calculating the ability of all alternatives to accomplish all tasks. Virtually no prejudgment is involved regardless of the experience, etc. of the user. An analysis which employs this methodology must therefore perform a complete comparative analysis as one of the primary and required inputs.

Cost Effectiveness

The method is based on the principle of examining fixed-effectiveness variable-cost. That mix of fire support systems or units which can accomplish all tasks for the least cost is the mix selected. This does not necessarily mean that the cost of accomplishing any one task is minimized. It is important to note that the method also takes into account the problems of task accomplishment as a function of time; for any given set of tasks a different mix would be selected if all the tasks must be accomplished simultaneously as against being accomplished sequentially, or as against some being accomplished each way.

Optimum Force Mix

The objective of this study was to develop a method for determining "optimum" fire support mixes. Specifically the study provides a tool for

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calculating results for a mix consisting of cannon and rocket artillery, attack helicopter fire support, and fighter bomber fire support.

Resource Implications and Alternative Force Structure

Since the method determines unit mixes and cost of task accomplishment it could be applied to higher level, lower resolution problems. For example, the resource implications of non-optimum unit mixes are a direct output of the mix submodel. Further, the ratio of supporting units to supported units, which is also an output of the process, has many force structure implications.

Attachment 15

Title: Cost-Effectiveness Comparison of Artillery Systems for Support of Airmobile Operations[20]

Source: Research Analysis Corporation

Date: May 1967

SCOPE

The study considered three classes of fire support systems to support airmobile operations in two military situations. The 1970-80 timeframe was used in specifying the system characteristics and scenarios used. All systems were compared on their relative mobility, lethality, responsiveness, survivability, and flexibility. Fifteen alternative systems were analyzed, ten were helicopter-transportable artillery, four were aerial artillery, and one was the attack helicopter. In general, the methodology employed was to specify fixed cost and examine the resultant effectiveness.

PROBLEM

In March 1965, the Army stated an objective for an aerial-artillery weapon with mobility characteristics commensurate with airmobile maneuver forces. This weapon was to replace, in a single system, conventional tube-artillery and attack helicopters.

As part of the concept formulation process, RAC was requested to undertake a study to compare the cost and effectiveness of alternative system concepts and to determine the value of the new aerial artillery concept relative to alternative and existing means for accomplishing the same mission.

METHODOLOGY

The study is a cost-effectiveness comparison based on the equal cost form. A fixed budget is assumed and the analysis determines which of the 15 alternatives result in the greatest effectiveness for the same expenditure of resources. The objective function used for the determination of effectiveness is the mission of artillery (i.e., to

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assist maneuver forces to accomplish their mission through the use of firepower).

Equal cost alternatives were exercised in Southeast Asia and the Middle East in representative tactical situations selected from war games and combat reports. Each alternative was compared on the basis of its performance in the accomplishment of maneuver requirements and fire missions in these situations. Quantitative system performance characteristics were measured where practicable. A computer program was developed to compute casualty producing capability. The overall measure of effectiveness is the aggregate of interrelated factors both quantitative and qualitative.

RELEVANCE

The report treats aspects of the following subjects:

Tactical Situations in SEA and the Middle East
Weapons Technology
Aircraft Technology
Fire-Control Technology
Resource/Cost Analysis
System Lethality and Vulnerability
TOE Implications

The study makes an effort to show objectively the way indirect fire from the ground and direct fire from the air complement and supplement one another when providing fire support to US forces in contact with the enemy.

Weapon System Analysis

Extensive analysis regarding the performance of weapon system concepts was performed. It is shown in both the main body and the appendices of this report. This effort was needed in order that a rational comparative analysis of each equal cost alternative could be performed.

Comparative Analysis and Cost Effectiveness

As stated, this study employed equal cost techniques. Therefore, it was imperative that a thorough cost analysis be performed early in the program. Equal cost alternative forces were then compared regarding their relative ability to accomplish given missions.

Target Analysis and Technological Forecasting

Forecasts regarding potential military situations and enemy unit deployment in each situation were made so that artillery missions could be specified. Since some of the artillery systems used to perform these missions contained conceptual subsystems (i.e., weapons and aircraft) a technological forecasting was needed in order to derive and substantiate estimates of system performance capabilities and limitations.

Weapon System Characteristics and Resource Implications

The majority of the system characteristics used for this study were provided by various Department of Army Commands and Laboratories. As indicated in the preceding section, however, some of these were subject to modification or revision since they were based on projections and estimates.

Since the study employed system and unit cost information as one of its primary inputs, it contains a number of implied and explicit resource implications.

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Attachment 16

Title: Final Report on Impact of Semi-Active Laser Guidance [21]

Source: Research Analysis Corporation

Date: April 1972

SCOPE

The study emphasis is on second-generation semi-active laser guidance systems in the 1975-1990 time period. Consideration is given to both air- and ground-deployed weapons and illuminators in nonnuclear, mid-intensity European conflicts as well as low-intensity conflicts. The merit of laser-guided ordnance is assumed to be established, therefore, comparison with other terminal homing concepts is not made.

PROBLEM

To define potential application, combat limitations, and interfaces among semi-active laser guidance systems, weapon concepts employing these guidance systems, and opportunities for joint-service support of semi-active laser-guided weapon development programs.

METHODOLOGY

Weapon systems based on semi-active laser-guided ordnance were examined and the major parameters that influence mission performance identified. Constraints on the major parameters caused by operational procedures, countermeasures, environment, and threat were examined. The operational effectiveness of the weapon systems was then determined for the major parameters.

RELEVANCE

Consideration of the interaction of laser systems with close air support (CAS) occur throughout the report. Some of the relationships discussed have much in common with other weapon systems, such as vulnerability to air defense and command and control problems. Others reflect the unique characteristics of the laser systems and, hence, pose either new

restrictions on or allow new freedoms to the application of CAS.

Military Situation and Threat Analysis

One chapter is devoted to an engagement analysis in which a characteristic threat on a battalion size scale is posed to friendly defensive positions. The air defense threat to friendly CAS units is also discussed.

Technological Forecast

Discussion of systems and countersystems on the forefront of the state-of-the-art is included, with implications to the efficacy of CAS mentioned though not stressed.

Weapon System Characteristics, Performance, and Analysis

The limitations and capabilities of laser guided systems are discussed with relation to accuracy, guidance, lethality, countermeasures, and other such considerations.

Comparative Analysis

Air-based and ground-based illumination and weapon delivery are compared. Preferred system combinations for various expected situations are recommended.

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13. ABSTRACT

The study objectives were: to analyze many of the factors which affect or constrain close air support operations; to assist the Army in developing and applying criteria for evaluating close air support command, control, basing, and logistics concepts; to review a number of studies and experiments which pertain to the subject of close air support, and to broadly structure an analytical procedure for evaluating close air support resources under conditions of prolonged combat.

The factors or constraints analyzed were in such areas as the influence of the characteristics of the threat, air-to-ground weapons technology, and the effects of environmental, operational, and economic factors on close air support operations.

Criteria were developed for command, control, and basing concept evaluation in the categories of close air support responsiveness, survivability, accuracy, lethality, and availability.

Sixteen reports were reviewed and described according to report content in a common format containing eleven areas of possible interest to the research analyst. These areas include threat analysis, cost and effectiveness comparisons, and force structure or mix determinations.

An expected-value, time-step simulation model was developed to evaluate attack helicopter performance over prolonged periods of combat. Sensitivity runs were made to determine the effects of variations in demand sequence, weather, maintenance penalty, attrition, and response time.

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model						
operational factors						
responsiveness						
sensitivity analysis						
simulation						
survivability						