AN ANALYSIS OF MAJOR TRAINING AREA OPERATIONS IN V CORPS, US ARMY EUROPE

Michael John Moore
and
Thomas Joseph Teesdale

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ANALYSIS OF MAJOR TRAINING AREA OPERATIONS
IN V CORPS, US ARMY EUROPE

by

Michael John Moore

Thomas Joseph Teesdale

September 1977

Thesis Adviser: S. H. Parry

Approved for public release; distribution unlimited.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) An Analysis of Major Training Area Operations in V Corps, US Army Europe		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis September 1977 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Michael John Moore Thomas Joseph Teesdale		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1977 13. NUMBER OF PAGES 150
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Training Operations
Scheduling of Training Operations
Movement to Training Sites
Supply Costs Associated with Training

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis presents the results of applying operations research to V Corps' Major Training Area (MTA) operations in the Federal Republic of Germany. The study examines three aspects of these MTA operations; the movement of tracked vehicles to training sites; the prediction and allocation of supply costs associated with MTAs and the scheduling of MTA operations. The

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
(Page 1) S/N 0102-014-6601 |

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

thesis concentrates on developing methodologies which are immediately implementable by V Corps and which will assist the Corps commander and his staff in their efforts to solve problems in these three areas. The thesis develops a computer assisted scheduling system with a user's guide, and sets forth MTA movement costs and aspects of MTA supply costs for consideration by the commander and his staff in the decision making proccess.

AN ANALYSIS OF MAJOR TRAINING AREA OPERATIONS IN V CORPS, US ARMY EUROPE

by

Michael John Moore
Captain, United States Army
B.S., University of Scranton, 1971

Thomas Joseph Teesdale
Captain, United States Army
B.S., United States Military Academy, 1971

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 1977

ABSTRACT

This thesis presents the results of applying operations research to V Corps' Major Training Area (MTA) operations in the Federal Republic of Germany. The study examines three aspects of these MTA operations: the movement of tracked vehicles to training sites; the prediction and allocation of supply costs associated with MTAs and the scheduling of MTA operations. The thesis concentrates on developing methodologies which are immediately implementable by V Corps and which will assist the Corps commander and his staff in their efforts to solve problems in these three areas. The thesis develops a computer assisted scheduling system with a user's guide, and sets forth MTA movement costs and aspects of MTA supply costs for consideration by the commander and his staff in the decision making proccess.

TABLE OF CONTENTS

I. INTRODUCTION.................................... 13

II. BACKGROUND...................................... 15

A. OVERVIEW OF MAJOR TRAINING AREA OPERATIONS... 15

B. SCHEDULING MAJOR TRAINING AREA OPERATIONS.... 18

C. MAJOR TRAINING AREA OPERATIONS AND THE V CORPS MISSION BUDGET........................ 20

1. Budget Requirements Generated by MTA Operations.................................. 20

2. MTA Operations Budget Requirements by Element of Expense........................ 22

3. Predicting the Cost of MTA Operations.... 22

4. Monitoring the Cost of MTA Operations.... 26

5. Distribution of Resources Necessary to Conduct MTA Operations.................. 27

D. SUMMARY..................................... 28

III. STATEMENT OF THE PROBLEM....................... 29

A. MOVEMENT OF UNITS TO MAJOR TRAINING AREAS.... 29

1. Rail..................................... 29

2. Management of Rail Movement.............. 29

3. Objectives of the Analysis............... 30

B. SUPPLY COSTS AND MAJOR TRAINING AREA OPERATIONS................................ 31

1. Budget Justification..................... 31

2. Allocation of Resources.................. 31

3. Assessing Supply Costs................... 31

4. Objectives of the Analysis............... 32

C. SCHEDULING MAJOR TRAINING AREA OPERATIONS.... 32

1. Problems Associated with the Manual Scheduling System....................... 32

2. Proposed Solution........................ 32

IV. MOVEMENT OF UNITS TO MAJOR TRAINING AREAS........ 34
A. ALTERNATIVES.. 34
B. ANALYSIS OF RAIL MOVEMENT........................... 34
1. Description of Data................................. 34
2. Analysis of Rail Movement Costs..................... 35
C. ANALYSIS OF TRUCK TRANSPORTERS...................... 37
1. Available Resources................................. 37
2. Description of Data................................. 39
3. Cost Analysis....................................... 39
D. ANALYSIS OF PREPOSITIONING EQUIPMENT
AT MAJOR TRAINING AREAS................................ 40
1. Alternatives.. 40
2. Prepositioning at Grafenwoehr....................... 40
3. Prepositioning M60A1 Tanks.......................... 42
4. Other Alternatives.................................. 43
E. ROAD MARCHING....................................... 44
F. EMPIRICAL RESULTS................................... 44
G. CONCLUSIONS... 45
V. ANALYSIS OF SUPPLY COSTS ASSOCIATED
WITH MAJOR TRAINING AREA OPERATIONS..................... 47
A. SUPPLY CATEGORIES................................... 47
B. ANALYSIS OF METHODOLOGY............................. 47
C. ALTERNATIVE METHODOLOGY I........................... 49
1. Description of the Data............................. 49
2. Conclusions... 50
D. ALTERNATE METHODOLOGY II............................ 51
1. Hypothesis.. 51
2. Cost Factors as Expected Values..................... 51
3. Research Analysis Corporation Study................. 52
4. Additional Data..................................... 53
5. Analysis of the Data................................ 54
a. Composition of Tank Battalions
by Age... 54
b. Demand Data for Tank Components..................... 55
6. Conclusions... 56
VI. SCHEDULING MAJOR TRAINING AREA OPERATIONS.......... 58

A. A COMPUTER ASSISTED APPROACH TO SCHEDULING... 58
B. DESCRIPTION OF THE COMPUTER ASSISTED SCHEDULING SYSTEM.................................. 59
1. General.................................. 59
2. Dissemination of Initial Scheduling Guidance................................. 59
3. Submission of Training Requests.......... 65
4. Compiling and Maintaining the MTA Schedule................................. 66
C. THE DECISION LOGIC FOR THE SCHEDULING PROGRAM.................................... 67
D. THE CAPABILITIES OF THE V CORPS MTA SCHEDULING PROGRAM........................ 68
E. SUMMARY..................................... 72
VII. CONCLUSIONS..................................... 77
A. MOVEMENT.................................... 77
B. SUPPLY COSTS................................ 77
C. SCHEDULING.................................. 78
Appendix A: COMPUTING RAIL MOVEMENT COSTS.............. 79
Appendix B: BATTALION COST MATRICES ($)................ 82
Appendix C: RAIL COST ($) SUMMARY...................... 89
Appendix D: HEAVY EQUIPMENT TRANSPORTER COSTS ($)...... 96
Appendix E: HEAVY EQUIPMENT TRANSPORTER COMPANY COSTS ($)................................ 100
Appendix F: SUMMAY DATA FOR TEST SCHEDULE.............. 101
Appendix G: DATA FROM RMER/UNIT TRAINING SCHEDULES..... 103
Appendix H: REPAIR PART DEMANDS AND TANK FLEET AGE..... 114
Appendix I: USER'S GUIDE FOR THE V CORPS MTA SCHEDULING PROGRAM........................ 126
LIST OF REFERENCES.................................... 148
INITIAL DISTRIBUTION LIST............................. 149
LIST OF TABLES.. 8
LIST OF FIGURES....................................... 12

LIST OF TABLES

I V Corps Major Training Areas.................... 16

II List of V Corps Training Categories............. 18

III Distribution of V Corps FY 1977 Program 20 Mission Funds.................................. 21

IV A Percentage Comparison of the Major Training Area Operations Budget for FY 1977.............. 21

V Projected Major Training Area Operations Costs by Element of Expense for FY 1977............... 23

VI Cost Matrix($)--M60A1 Tank....................... 36

VII An Example of the Information Needed to Divide USAREUR Training Allocations into Training Periods................................ 62

VIII An Example of an Information Chart For Tank Gunnery, Level One Prepared from the FY 1978 USAREUR Major Training Area Schedule....................................... 63

IX An Example of an Information Chart for Maneuver Training Prepared from the FY 1978 USAREUR Major Training Area Schedule.................. 64

X Cost Matrix($)--Armor Bn w/M60A1................. 83

XI Cost Matrix($)--Mechanized Infantry Bn.......... 84

XII Cost Matrix($)--Armored Cavalry Squadron w/M551A1... 85

XIII Cost Matrix($)--175MM SP Field Artillery Bn..... 86

XIV Cost Matrix($)--8 Inch Field Artillery Bn....... 87

XV Cost Matrix($)--155MM SP Field Artillery Bn..... 88

XVI Rail Cost($) Summary for Individual Vehicles.... 90

XVII Rail Cost($) Summary--Armor Bn w/M60A1.......... 93

XVIII Rail Cost($) Summary--Armor Bn w/M60A2.......... 93

XIX Rail Cost($) Summary--Mechanized Infantry Bn.... 94

XX Rail Cost($) Summary--Armored Cavalry SQD w/M551A1....................................... 94

XXI Rail Cost($) Summary--175MM SP FA Bn............ 95

XXII Rail Cost($) Summary--8 Inch FA Bn.............. 95

XXIII Rail Cost($) Summary--155MM SP FA Bn............ 95

XXIV Road Distances (miles)........................... 97

XXV HET Movement Costs($)........................... 98

XXVI S and P Movement Costs($)....................... 99

XXVII HET Company Costs($)............................100

XXVIII Summary Data for Test Schedule...................101

XXIX RMER Data-2/75 FA Bn, 41st Arty GP, 8 IN SP.....104

XXX RMER Data-2/5 FA Bn, 41st Arty GP, 175MM SP.....105

XXXI RMER Data-1/32 FA Bn, 41st Arty GP, Lance.......106

XXXII RMER Data-2/83 FA Bn, 41st Arty GP, 8 IN SP.....107

XXXIII RMER Data-6/9 FA Bn, 42nd Arty GP, 175MM SP.....108

XXXIV RMER Data-3/79 FA Bn, 42nd Arty GP, Lance.......109

XXXV RMER Data-2/92 FA Bn, 42nd Arty GP, 8 IN SP.....111

XXXVI RMER Data-1/333 FA Bn, 42nd Arty GP, Lance......112

XXXVII Repair-Part Demands/Fleet Age--1/32..............115

XXXVIII Repair-Part Demands/Fleet Age--2/32..............116

XXXIX Repair-Part Demands/Fleet Age--3/32..............117

XL Repair-Part Demands/Fleet Age--1/33..............118

XLI Repair-Part Demands/Fleet Age--2/33..............119

XLII Repair-Part Demands/Fleet Age--3/33..............120

XLIII Repair-Part Demands/Fleet Age--1/68..............121

XLIV Repair-Part Demands/Fleet Age--2/68..............122

XLV Repair-Part Demands/Fleet Age--3/68..............123

XLVI Repair-Part Demands/Fleet Age--5/68..............124

XLVII Repair-Part Demands/Fleet Age--4/69..............125

XLVIII Examples of Valid and Invalid Unit Designation Codes..............129

XLIX Code Numbers for V Corps Major Headquarters.....130

L Type Unit Code Numbers..............132

LI Training Category Code Numbers..............133

LII Program Constraints on the Maximum Number of Periods Authorized for Each Training Category..............134

LIII Program Density Constraints by Training Category..............135

LIV Location Code Numbers..............137

LV Data Card Column Assignments for Period Allocations..............139

LVI An Example of Period and Density Allocations by Training Category..............142

LVII Data Card Column Assignments for Information Required on Each Training Request................143

LIST OF FIGURES

1. Map of V Corps Major Training Area Locations........ 17

2. The V Corps Training Matrix........................... 25

3. An Example of the Statistics Summary Printed by the V Corps Major Training Area Scheduling Program................................ 73

4. An Example of Schedule Format Option One Printed by the V Corps Major Training Area Scheduling Program... 74

5. An Example of Schedule Format Option Two Printed by the V Corps Major Training Area Scheduling Program................... 75

6. An Example of Schedule Format Option Three Printed by the V Corps Major Training Area Scheduling Program................... 76

7. An Example of a Valid Output Control Card...........140

8. The Final Card of the Data Deck.....................144

9. The Proper Arrangement of the Data Deck.............145

10. The Proper Arrangement of the Scheduling Program Deck.....................................147

I. INTRODUCTION

The Dictionary of United States Army Terms (AR 320-5) defines operations research as: "The analytical study of military problems, undertaken to provide responsible commanders and staff agencies with a scientific basis for decision on action to improve military operations." In the spirit of this definition, the authors examined the Major Training Area (MTA) operations in V Corps, U.S. Army Europe and have addressed three topics of concern to the Corps Commander and his staff. These three topics include: 1) the movement of men and equipment to the MTAs, 2) the supply costs generated by MTA exercises, and 3) the scheduling of MTA operations.

Chapter II presents background information explaining the impact of MTA operations on the V Corps training program and budget. Chapter III contains the statement of the problem which describes in detail the topics analyzed and explains why these topics were chosen. Chapter IV examines the movement of units to MTA locations, and compares various modes of transportaion to include rail, truck, and road marching. The objective of this analysis is to increase the combat training which can be accomplished within the constraints of the movement budget. In Chapter V, the supply costs associated with MTA operations are examined in order to provide V Corps with the facility to accurately predict the cost of these training events. Additionaly, this section suggests a methodology for the allocation of supply funds and evaluates the feasibility of assessing the expenditure of supply funds to specific training events. Chapter VI describes a computer assisted scheduling

system which has been developed to assist the V Corps G-3 section in the preparation and management of the MTA schedule. Finally, Chapter VII presents a summary of the conclusions developed in each chapter of this study.

II. BACKGROUND

A. OVERVIEW OF MAJOR TRAINING AREA OPERATIONS

The strategic positioning of United States ground forces in Europe has generated a critical training problem: there exists an insufficient number of training areas co-located with each combat, combat support, and combat service support battalion-size element to allow these units to complete their required training programs. U.S. Armed Forces in the Federal Republic of Germany are positioned in garrisons which are typically located within, or adjacent to, cities or small towns; therefore, the development of large training reservations is not generally feasible. As a result the North Atlantic Treaty Organization has established a series of twenty Major Training Areas (MTA) throughout the Federal Republic of Germany. These MTAs provide the facilities and the maneuver space necessary to accomplish the following training requirements:

1. live fire of the main gun on the M60 series tanks, or equivalent weapons systems;

2. live fire of selected small arms and crew served weapons;

3. live fire of artillery weapons;

4. live fire of helicopter mounted weapons systems; and

5. large scale tactical maneuvers.

The primary MTAs utilized by elements of V Corps are Baumholder, Grafenwoehr, Hohenfels, and Wildflecken. The capabililies of these training areas are summarized in Table I, and their geographical positions are shown in Figure 1.

Table I - V CORPS MAJOR TRAINING AREAS

TRAINING AREA	TYPES OF TRAINING	LOCATION
Baumholder	Small arms and crew served weapons firing; maneuver	100 kilometers southwest of Frankfurt
Grafenwoehr	Small arms and crew served weapons firing; mortar and artillery firing; tank firing; maneuver	300 kilometers southeast of Frankfurt
Hohenfels	Live fire maneuver; maneuver	350 kilometers southeast of Frankfurt
Wildflecken	Tank firing; live fire maneuver; maneuver	100 kilometers northeast of Frankfurt

The importance of the training conducted at the MTAs cannot be over emphasized. In the Guidlines for Formulating Mission Budgetary Requirements for the Fiscal Year (FY) 1977 Command Operating Budget, [Ref. 1], eight categories of training were identified and prioritized. These training categories are listed in Table II in the order of their priority. Those items followed by an asterisk denote operations which were conducted at MTAs.

Figure 1 - MAP OF V CORPS MAJOR TRAINING AREA LOCATIONS

Table II - LIST OF V CORPS TRAINING CATEGORIES

TRAINING CATEGORY	PRIORITY
* Unrestricted Readiness Test	1.
* Annual Service Practice	2
* Army Readiness Training Evaluation Program	3
* Major Training Area Exercise	4
Garrison	5
Local Training Area Exercise	6
Command Post Exercise	7
Field Training Exercise	8

Note: * Denotes training conducted at a major training area.

B. SCHEDULING MAJOR TRAINING AREA OPERATIONS

The Grafenwoehr, Hohenfels, and Wildflecken training areas are administered by the 7th Army Training Center, USAREUR. The Baumholder training area is administered by the Commander, V Corps. As directed by USAREUR Regulation 350-10, dated 12 January 1977, the Deputy Chief of Staff, Operations, USAREUR coordinates and publishes a schedule for Grafenwoehr, Hohenfels, Wildflecken, and Baumholder during the first quarter of each fiscal year. This schedule provides USAREUR major commands and allied forces with information concerning MTA availability. The schedule designates, by MTA, the units which have priority for use of

the training area facilities; the inclusive dates of priority periods; the specific type training authorized; and the density, or number of battalion-size elements, which may participate in training.

To develop the FY 1977 MTA schedule, the Corps G-3 Training Section began by extracting all V Corps MTA allocations from the USAREUR schedule. Next, a completely manual scheduling system was implemented in the following stages:

Stage 1: MTA allocations were distributed to all V Corps subordinate commands. Special instruction were also provided in order to reduce schedule conflicts.

Stage 2: Each major command coordinated with their battalion-size elements and prepared a list of desired training periods.

Stage 3: These requests were returned to V Corps where they were consolidated into a master schedule. Conflicts were resolved through coordination with USAREUR for additional time or training densities, where a training density represents the authorization to train a battalion size force at a designated training area. When these requests were refused, requesting units were required to reschedule their training.

Stage 4: A feasible consolidated schedule was distributed to V Corps units and to USAREUR. This action marked the beginning of an indefinite period of processing scheduling changes.

Several points must be noted regarding this procedure. First, the preperation of this schedule represented an extensive, tedious manual effort requiring an

elaborate system of checking and rechecking available densities, dates, and units requesting training. V Corps must schedule a maximum of sixty-four individual battalions into these MTAs each year, and many of these battalions must be scheduled two or three times in order to participate in different types of training. Second, the scheduling process must be a dynamic system which is capable of preparing the initial schedule and of processing numerous changes to this schedule during the entire year. Finally, the system must process these changes without violating the time and density constraints established for each MTA.

C. MAJOR TRAINING AREA OPERATIONS AND THE V CORPS BUDGET

1. Budget Requirements Generated by MTA Operations

The V Corps FY 1977 Command Operating Budget included four separate program elements. The funds required to conduct MTA operations were included in Program 20 (P20) within the subprogram of Mission Funds. This subprogram provided the resources to support tactical field training, expenses incurred in travel and per diem by V Corps sponsored personnel, the cost of air travel for personnel on emergency leave orders, the costs associated with contractual services requirements, the funds used to support Civil Affairs functions, and the expense incurred by the local procurement of authorized supplies and equipment not available in the normal supply system. The funds necessary to support MTA operations are included in those P20 Mission Funds committed to tactical field training. A breakdown of the total P20 Mission Funds is given in Table III. These figures were taken from the FY 1977 V Corps Budget Execution Review. The effect of MTA operations on

this budget is demonstrated by the training program ratio comparisons given in Table IV.

Table III - DISTRIBUTION OF V CORP'S FY 1977 PROGRAM 20 MISSION FUNDS

	TOTAL PROGRAM 20 MISSION BUDGET	$79,187,400
1.	Portion of Program 20 Mission Budget allocated to Training Operations.	$47,251,000
	- Portion of Training Operations Budget allocated to Major Training Area Operations.	$26,285,000
2.	Portion of Program 20 Mission Budget for all activities except training operations.	$31,936,400

Table IV - A PERCENTAGE COMPARISON OF THE MAJOR TRAINING AREA OPERATIONS BUDGET FOR FY 1977

Percentage of Total Program 20 Mission Funds Allocated to Major Training Area Operations:	33.2
Percentage of the Training Operations Budget Allocated to Major Training Area Operations:	55.6

2. MTA Operations Budget Requirements by Element of Expense

V Corps determines the MTA operations budget by examining four separate elements of expense which are designed to describe any operation in terms of the resources required to support that training. These elements of expense are:

a. Rail Movement;

b. Supply Class III - all petroleum products;

c. Supply Classes II and IV - administrative supplies, individual equipment, organizational tools, and construction materials; and

d. Supply Class IX - repair parts.

The FY 1977 Budget Execution Review identified the projected funds required to support MTA operations in terms of these expense categories. These cost figures, and a percentage comparison of the elements of expense, are presented in Table V.

3. Predicting the Cost of MTA Operations

Each command utilized a battalion training matrix to summarize the Class III, Class IX, and rail costs required to support each operation in the battalion training program. An example of this training matrix is presented in Figure 2. The cost figures from all of these matrices for V Corps units were combined with the projected cost of

supply Classes II and IV to provide a total cost figure by element of expense.

Table V - PROJECTED MAJOR TRAINING AREA OPERATIONS COSTS BY ELEMENT OF EXPENSE FOR FY 1977

Total Major Training Area Budget Requirement: $26,285,000.

ELEMENT OF EXPENSE	BUDGET REQUIREMENT	PERCENTAGE OF MTA BUDGET
Rail Movement	$8,178,000.	31.1
Supply Class III	$4,702,000.	17.9
Supply Classes II, IV, and IX	$13,405,000.	51.0

Class III requirements were derived by dividing the total projected mileage for a type vehicle by an average mile-per-gallon performance factor for that vehicle. This calculation provided a total gasoline or diesel requirement in gallons. This procedure was followed for each type vehicle involved in training, and the total number of gallons required were multiplied by a fuel price index per gallon. Class IX requirements were computed by multiplying these same mileage figures for each type vehicle by a repair parts cost factor per mile driven. These cost factors were provided by the Office of the Assistant Chief of Staff Resource Management, V Corps [Ref. 2].

The costs associated with rail transportation to the

MTAs were based on directives contained in a convention between the Deutsche Bundesbahn (German Railroad) and the United States Forces in Europe, [Ref. 3]. Appendix A contains a list of references for this convention and the methodology which it describes for computing rail movement costs. Briefly, the rail movement cost for each vehicle was predicted by multiplying the vehicle weight in 100 kilograms by a railway tariff rate which is dependent on the vehicle weight and the distance to be traveled. Additional charges can occur but no official documentation exists to account for all of them. As a result, several units developed computational methods to account for these charges in their budget predictions. The rail transportation expenditure represented a significant portion of the total MTA budget. As shown in Table V, V Corps must spend over thirty percent of its MTA funds to move equipment to and from the training sites by rail.

The prediction of the resource requirement from supply Classes II and IV involved multiplying the authorized peace time personnel strength of a command by a cost factor per man by the number of days required for training. The cost factor used in the FY 1977 Budget Execution Review was $.84 per man per day.

Command ____________ Type Bn ____________ No. This Type Bn in Command ____________

TYPE TNG	BN DAYS	MOGAS COST	DIESEL COST	CLASS IX COST	SUBTOTAL	RAIL COST	TOTAL
URT							
ASP							
ARTEP							
MTA							
GARR							
LTA							
CPX							
FTX							
OTHER							
TOTAL							

Figure 2 - THE V CORPS TRAINING MATRIX

4. Monitoring the Cost of MTA Operations

Cost Feeder Reports and the Deutsche Bundesbahn rail bills contained information documenting the actual cost of specific MTA operations. The feeder reports were prepared by each battalion and separate company after each MTA operation. The information contained in these reports included:

a. the type, duration, and location of the training;

b. the type and size of the unit participating in the training;

c. the number of military participants;

d. the type, number, and total miles driven by all track and wheeled vehicles engaged in training;

e. the amount of petroleum, oil, and lubricants expended during the training period; and

f. the estimated transportation or rail cost incurred.

Given accurate report data, this system can monitor the expenditures for any single MTA operation in terms of supply Classes II, III, and IV. The shortfall of this reporting system is that the Class IX costs generated by the training cannot be identified, and these expenditures account for over fifty percent of the MTA budget. Further, no available accounting system could evaluate the accuracy of the cost per mile factors used to predict repair parts

costs.

The rail bills for MTA moves were processed through the USAREUR Central Accounting Office, then forwarded to the 18th Finance Company, V Corps, and finally returned to the major command involved in the move. The bills were processed by individual train moves and not by training exercise. No records were maintained which compared projected rail expenditures to the true cost of the shipment.

5. Distribution of Resources Necessary to Conduct MTA Operations

In FY 1977, the V Corps commander instituted a policy where by he made a formal contractural agreement with each major commander under his authority. This contract represented a mutual understanding of the resources to be provided for the purpose of achieving a specified level of combat readiness. Similar contracts were then developed between commanders down to battalion level. Funds required to support MTA training were included as part of these contracted resources.

The actual distribution of resources was accomplished by the Control of Logistics Expenditures (COLEX) System. Each unit authorized to initiate a DA Form 2765 (Request for Issue or Turn-In) was allocated a quarterly demand ceiling. This ceiling represented a gross sum for all supply requirements, thus allowing unit commanders to decide which class of items to procure. Allocations were made based on the projected training events scheduled for the quarter. Thus, if all other training requirements were equal, a command scheduled to participate in MTA training would receive a larger COLEX

allocation to satisfy the Class II, III, IV, and IX expenditures generated by that training.

D. SUMMARY

This section has presented a description of MTA operations and an explanation of the scheduling and budgetary requirements within V Corps, USAREUR, which are generated by this training. The next section outlines the specific MTA related topics analyzed in this report, and explains why these topics were chosen.

III. STATEMENT OF THE PROBLEM

A. MOVEMENT OF UNITS TO MAJOR TRAINING AREAS

1. Rail

The rail budget has been a constraint on the amount of training V Corps has been able to accomplish in recent years. The funded rail budget for FY 1977 was less than the projected rail movement costs for V Corps' minimum training requirements. Since the rail rates are in German Marks, the dollar devaluation versus the mark has increased the rail budget's importance. The 8 million dollar rail budget for FY 1977, calculated at 2.60 marks per dollar, was inflated to 8.9 millicn dollars at the August 1977 rate of 2.32 marks per dollar. In June 1977, it was apparent that essential combat training might be deleted from the Corps' training schedule due to budget constraints.

2. Management of Rail Movement

a. The individual battalion and brigade commanders were allowed maximum discretion with regard to selecting their unit's mode of travel to MTAs. Rail movement was usually selected for the advantages it provided. Some of these are given below:

(2) Rail offered the shortest movement time

over long distances.

(2) Rail movement maintained unit integrity during the movement and provided the commander with control of his unit.

(3) Rail movement did not draw on the unit's fuel allocation.

Early in FY 1977, V Corps was reluctant to dictate that rail movement would not be used, even if cheaper alternatives were available. One reason for this reluctance was that V Corps was expecting additional funds from USAREUR in mid-year. In June 1977, it appeared that additional funds would not be made available.

b. The method of predicting and estimating rail movement costs was complex and time consuming, and it did not provide the unit commanders or Corps staff with a good management tool. The cost advantages or disadvantages of alternatives to rail movement were unclear due to the German railroad's rate scale. At the same time, the unit commanders and the V Corps staff were not fully aware of the heavy equipment transporter (HET) assets available from USAREUR or within the Corps.

3. Objectives of the Analysis

The ultimate objective of the analysis is to increase combat training within the constraints imposed by the rail movement budget. To achieve this goal, a number of intermediate steps are required:

a. Identify feasible alternatives to the present system;

b. Collect data on the alternatives and analyze their contribution to the overall goal;

c. Provide V Corps unit commanders and their staffs with a simple methodology for optimizing movement to MTAs.

B. SUPPLY COSTS AND MAJOR TRAINING AREA OPERATIONS

1. Budget Justification

Expenditures for supplies were projected at 63 million dollars in V Corps' FY 1977 budget. This represented 80 percent of the mission budget. Attempts to link supply costs with training activities had only limited success prior to June 1977. If V Corps was able to accurately associate supply costs with training, then efforts to justify budget levels as a function of combat readiness would be enhanced.

2. Allocation of Resources

V Corps allocated funds to subordinate units based on projected training activities. The portion designated for supplies was usually subject to the greatest error. This fact created management difficulties at all command levels.

3. Assessing Supply Costs

To verify supply cost predictions, it is imperative

that V Corps have the ability to monitor current expenditures in relation to training. V Corps has a number of automatic data processing systems which monitor supply demands and costs. However, none of these systems could link supply costs with training activities. Unit after-action reports on costs were also limited in their ability to assess supply costs to discrete training events.

4. Objectives of the Analysis

The objective of the analysis is to provide V Corps with the facility to accurately predict supply costs for its training activities. Additional objectives are to give V Corps the capability of properly allocating supply funds and assessing the expenditure of funds to training activities.

C. SCHEDULING MAJOR TRAINING AREA OPERATIONS

1. Problems Associated with the Manual Scheduling System

The scheduling system which was employed during FY 1977 to prepare the initial MTA schedule, and to monitor changes to this schedule, required an extensive, continuing manhour commitment. The effort involved in this process was dominated by the requirement to continuously check and cross check authorized densities against existing schedule commitments and new requests. This effort was tedious and vulnerable to oversight and human error.

2. Proposed Solution

A computer assisted scheduling system, which utilizes existing V Corps computer assets, will reduce the manhours required to effectively manage the scheduling of MTA operations and to disseminate the schedule information.

IV. MOVEMENT OF UNITS TO MAJOR TRAINING AREAS

A. ALTERNATIVES

A number of posible alternatives for movement to MTAs are available. Those which warrant a detailed investigation are as follows:

1. minimizing the total rail movement through the annual schedule;

2. insure optimal loading configurations on each rail car;

3. maximizing the use of heavy equipment transporters;

4. prepositioning stocks of equipment at the training sites; and

5. road marching tracked vehicles over the civilian road network under their own power.

B. ANALYSIS OF RAIL MOVEMENT

1. Description of Data

a. The existing data for rail movement was in two

forms: the rail freight tables and aggregate battalion movement costs. The rail freight tables were the basis of all final costs; however, extensive and time consuming calculations were required (as outlined in Chapter II) prior to obtaining vehicle shipping costs. The available aggregate predictions did not include all possible situations. In addition, there were inconsistencies in predictions from unit to unit. To fully understand the nature of the total rail expenditure, it was essential to have individual vehicle shipping costs and aggregate battalion shipping costs for all possible situations.

b. Based on the German railroad rate scale as of June 1977, individual shipping costs were computed by the authors using the Naval Postgraduate School's IBM 360/67 computer. These results were then used to compile the total shipping costs for each type battalion. The costs are listed in matrices which show charges for shipments from unit locations to MTAs. Each vehicle and feasible loading configuation has one matrix. Costs for each type battalion are given in the same format and are presented in Appendix B. The cost matrix for the M60A1 tank is presented in Table VI as an example of the individual vehicle matrices. Entries in the table are in dollars and were calculated using a 2.32 mark to dollar exchange rate.

2. <u>Analysis of Rail Movement Costs</u>

An examination of the data, summarized in Appendix C, revealed the following facts.

a. The mean shipping costs for each type vehicle varies from $861 for the M60A2 tank to $161. for the M113A1 armored personnel carrier.

Table VI - COST MATRIX($)--M60A1 TANK

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	590.	895.	797.	838.	452.
BAD HERSFELD	876.	985.	912.	932.	639.
BAD KISSIGEN	838.	714.	673.	614.	415.
BAD KREUZNACH	324.	1062.	1004.	838.	695.
BAUMHOLDER	0.	1177.	1119.	1119.	838.
BUEDINGEN	673.	951.	857.	895.	415.
BUTZBACH	639.	985.	912.	932.	565.
DARMSTADT	516.	951.	876.	895.	539.
FRANKFURT	526.	951.	876.	895.	516.
FRIEDBURG	614.	966.	895.	912.	526.
FULDA	776.	912.	816.	838.	360.
GELENHAUSEN	639.	932.	838.	876.	388.
GIESSEN	695.	932.	951.	966.	565.
GRAFENWOEHR	1177.	0.	526.	289.	876.
HANAU	577.	912.	816.	838.	439.
HOHENFELS	1119.	526.	0.	467.	776.
IDAR OBERSTEIN	164.	1149.	1092.	1092.	797.
MAINZ	452.	1004.	932.	932.	601.
MANNHEIM	554.	1021.	912.	951.	673.
VILSECK	1119.	289.	467.	0.	816.
WIESBADEN	452.	1004.	932.	951.	601.
WILDFLECKEN	838.	876.	776.	816.	0.

b. The loading configuration is important for cost reduction.

c. The tank battalions have the highest mean shipping cost ($57,622). The eight-inch artillery battalions have the lowest mean shipping cost ($9,497).

d. The M60A1 and M60A2 tanks are the significant contributors to the total rail costs of the armor battalions and armored cavalry squadrons. Eighty percent of the tank battalion's movement costs are generated by the 54 tanks in the unit. Thirty-one percent of the shipping cost for an armored cavalry squadron is for movement of its seventeen tanks.

e. Using the tank's mean shipping cost and assuming all 11 armor battalions ship each tank six times per year, a cost of 3 million dollars would be realized. Thus the armor battalion tanks could account for at least 40 percent of an eight million dollar rail budget.

The next step in the analysis is to develop methods of reducing the impact of tank movement costs on the rail budget.

C. ANALYSIS OF TRUCK TRANSPORTERS

1. Available Resources

a. The heavy equipment transporter system consists of a 45 ton tractor (M746) with a 60 ton trailer (M747). The primary mission of this transporter is the

evacuation of main battle tanks and similar vehicles. Its suitability as an alternative to rail depends on its availability, cost effectiveness, and operational characteristics.

(1) The 37th Transportation Group, 4th Transportation Brigade (a USAREUR level unit) has two transporter companies. Each company consists of 24 transporters, for a total of 48 in the Group. These assets are available upon V Corps' request. In June 1977 V Corps was receiving 36 transporters which were being placed in various Corps units. The primary mission of these vehicles was the evacuation of disabled tanks.

(2) A planning guide for the utilization of a transporter company includes the following factors.

(a) The mean number of transporters available at any time from a company is eighteen.

(b) An average of six days is required to move a tank battalion to a distant training site.

b. USAREUR had 1700 "Stake and Platform" trucks which consist of a five ton tractor and a twelve ton trailer. These vehicles are capable of transporting armored personnel carriers and other vehicles in the same weight category. Their primary mission is t e s ipment of supplies within the command. V Corps has almost two hundred stake and platform vehicles throughout the Corps. The availability of these vehicles to transport equipment to training sites is not constant and depends on their primary mission.

2. <u>Description of Data</u>

a. The 4th Transportation Brigade conducted a study to determine the operating costs of heavy equipment transporters and stake and platform trucks. This study indicated that the 4th Transportation Brigade could recover their fuel and repair-parts expenditures if they charged $2.08 per loaded mile for the heavy transporters and $0.44 per loaded mile for the stake and platform trucks. A loaded mile includes only the time that the truck is actually carrying a vehicle.

b. Using these rates and the milages from unit locations to training sites, shipping tables were generated. See Appendix D. The mean one-way shipping cost for tanks on heavy equipment transporters is $314. per vehicle. This compares favorablly with the mean rail costs for the M60A1 and M60A2: $778. and $861. respectively. The mean shipping cost for stake and platform trucks is $66. compared with the mean rail shipping cost of $161. for the armored personnel carrier.

3. Cost Analysis

The cost of activating a heavy transportation company is seven million dollars and annual recurring costs are three million dollars [Ref. 4]. One company is capable of offsetting $1,556,000. in rail shipment fees per year. This figure is obtained assuming a company can move 50 tanks per week during 40 weeks of the year. The rail cost for a ten year period has a present value of $9,555,396. This figure represents 37.5 percent of the total HET investment and operating costs for that period. Using a ten percent discount rate, the present value of the total HET cost is $25,423,000. See Appendix E for details of the calculations.

D. ANALYSIS OF PREPOSITIONING EQUIPMENT AT MAJOR TRAINING AREAS

1. Alternatives

A number of options exist which involve the positioning of equipment at the MTAs. The basic concept is to leave the unit vehicles in garrison, while the troops are moved to the MTA and train with equipment at the training site. The alternatives are as follows:

a. Preposition enough equipment at Grafenwoehr to accommodate all training performed at that location.

b. Preposition a limited amount of equipment at one of the MTAs to accommodate one specific type of training.

c. Each division sends battalion-size sets of equipment to the training site and the divisions train with that equipment.

d. Each unit reduces the number of weapon systems shipped to the training site for a particular training event.

2. Prepositioning at Grafenwoehr

Grafenwoehr is the largest training area and is able to accommodate 28 battalions at one time. The other MTAs are also used extensively because of the many units in USAREUR. The matter is further complicated because units

participate in three different types of training. Many units utilize two or more MTAs during the year. These facts and others influence the feasibility of prepositioning equipment at Grafenwoehr.

a. There are two types of tank battalions (M60A1 and M60A2). Their gun systems are different, and training on one system does not substitute for the other. This fact requires that both types of systems be prepositioned. Since there are few M60A2 battalions, it is not practical to maintain a battalion-sized set of M60A2 tanks at Grafenwoehr.

b. The 175MM gun system has the same low density problem. The 175MM field artillery battalion has only 12 gun systems. In addition the rail shipping costs for the 175MM gun is substantially lower than the M60A1 and M60A2. The eight inch artillery battalions have 12 weapon systems and the 155MM artilery battalions have 18 weapon systems. Also, their shipping costs are much lower than the M60A1 and M60A2 tanks. The number of each of these type battalions is low. These facts make it impractical to preposition equipment for the artillery battalions. The rail costs savings would be marginal.

c. Armored Cavalry Squadrons have a higher density of weapon systems than the artillery units, with 54 armored reconnissance vehicles (M551) and 17 main battle tanks (M60A1). The 54 M551s in the unit cost only slightly more to ship than the 17 main battle tanks. The small number of armored cavalry squadrons and relatively small shipping cost of the M551 compared to the main battle tank preclude the M551 from primary consideration as a prepositioning candidate.

d. The above facts are applicable to all training

sites.

3. Prepositioning M60A1 Tanks

a. The M60A1 weapon system represents the best prospect for prepositioning because of its high density and substantial rail shipping costs. Five battalion-sized sets are required to handle level one and level two gunnery at Grafenwoehr. The tactical situation makes this course of action extremely risky, since Grafenwoehr is in close proximity to the East/West border. Thus, the remaining alternative is to reduce the number of tanks prepositioned.

b. A battalion-sized set of M60A1s could be prepositioned for level one or level two gunnery. Level one gunnery is a 15 day program and level two gunnery is a nine day program. Ranges at Grafenwoehr are available from 215 to 270 days per year to USAREUR units. A battalion-sized set of tanks would therefore be able to handle approximately 16 level one or 26 level two programs per year. Each time a battalion fired on the prepositioned set, two rail movements would be eliminated. If the prepositioned set was devoted to level two gunnery, a total of 42 rail movements would be eliminated.

Tank gunnery level two is conducted at Grafenwoehr and Wildflecken. A prepositioned set of M60A1s at Grafenwoehr would save V Corps between $600,000. and $1,000,000. in rail costs. The exact amount depends upon how many rail shipments to Wildflecken are eliminated. The lower limit would be realized if all tank gunnery level two was originally scheduled for Wildflecken, and the upper limit would be realized if all tank gunnery level two was originally scheduled for Grafenwoehr. This assumes a period of one year and that nine M60A1 battalions use the

prepositioned set for tank gunnery level two. VII Corps' potential rail savings can be calculated in a similar manner; however, VII Corps' rail shipment costs were beyond the scope of this analysis.

c. Other aspects of stationing a set of M60A1s at Grafenwoehr which will increase the cost of prepositioning are given below. Extensive analysis would be required to estimate these costs since the total figure will be a function of the size of the prepositioned force.

(1) Maintenance personnel must be provided for the prepositioned set.

(2) Maintenance facilities must be built or existing facilities vacated by its occupants.

(3) The prepositioned set would incur high component failure rates because of extensive usage and the tanks left in garrision would have reduced component failure rates. This would alter the demand history for components and thereby distort stockage levels for repair parts at the battalion level.

4. <u>Other Alternatives</u>

a. An option which has been practiced by V Corps units is to reduce the number of weapon systems shipped to the training site. For example, a battalion could send 45 tanks instead of 54. The tank platoons can complete level one and level two gunnery programs with this reduced number of tanks. Reducing to 30 the number of tanks shipped to the training site will permit completion of a level two gunnery program, but will seriously hamper completion of a level one gunnery program.

b. Another option is based on the concept of each division sending one battalion set of equipment to the training site. The other battalions in the division would then train with this set. Experience indicates that this option is infeasible. Severe maintenance and tool accountability problems would develop. V Corps has not used this option for these reasons.

E. ROAD MARCHING

Movement of vehicles under their own power on the civilian road network is utilized in some shipments to training sites. This is the case when MTAs are close to the unit's garrison location. The tracked vehicles are not capable of high speed road movement, and for longer distances, movement time is an important factor. The failure rates of tracked vehicle components increase with milage, and the high cost of maintenance precludes extensive road marching. Furthermore, this mode of travel consumes scarce fuel resources and damages road surfaces.

F. EMPIRICAL RESULTS

To empirically estimate the rail movement cost savings obtainable through the use of heavy equipment transporters, stake and platform trucks, and road marches, a schedule has been constructed. All armor, artillery, armored cavalry and mechanized infantry battalions were scheduled for the minimum required training during a one-year period. Rail movement costs were compiled for this schedule and examined for possible reductions through the use of trucks or road

marching. Two levels of truck support were assumed. The first level assumed a maximum support level of one HET company per week and 50 stake and platform trucks per day. The second level assumed an increase to two HET companies per week. A summary of the results are at Appendix F.

The results indicate that the movement of tanks by heavy equipment transporters is able to reduce MTA rail movement costs by as much as 45 percent. If V Corps reimburses the 4th Transportation Brigade for the HET's operating expenses, the cost savings would be reduced to 26 percent. These operating expenses include fuel and repair-parts expenditures calculated at the 4th Transportation Brigade combined rate of $2.08 per loaded mile. Road marches and stake and platform trucks are only marginally effective compared to the HETs.

G. CONCLUSIONS

1. V Corps' best course of action is to make maximum use of the 4th Transportation Brigade's existing HET assets and the HET assets within the Corps to ship tanks to the training sites.

2. It is not cost effective to activate an additional HET company if its only mission will be to transport armor units to training areas. Only 37.5% of the total investment and ten year recurring cost for an activated HET company is offset by the elimination of rail movement cost.

3. Prepositioning one battalion-size set of M60A1 tanks at Grafenwoehr for level two gunnery is the best prepositioning option; however, this course of action does

not have as much potential for reducing rail costs as the maximum utilization of HETs.

4. The rail movement costs which can be eliminated by using stake and platform trucks are small compared with the savings possible with the use of HETs.

5. Road marching can eliminate some rail movement costs, but this option does not offer any large scale savings.

V. ANALYSIS OF SUPPLY COSTS ASSOCIATED WITH MAJOR TRAINING AREA OPERATIONS

A. SUPPLY CATEGORIES

Supply costs, related to training, fall into four major categories:

1. Class II consisting of individual equipment and organizational tools;

2. Class III consisting of petroleum products;

3. Class IV consisting of construction materiel; and

4. Class IX consisting of repair parts for equipment.

Class III represented seven percent of the Corps' mission budget at 5.8 million dollars, while Classes II, IV, and IX represented 73 percent of the budget at 57 million dollars.

B. ANALYSIS OF METHODOLOGY

Using the battalion training matrix concept, V Corps was able to assess 38.9 million dollars in supply costs to specific training events. Each formula used in the matrices has advantages and disadvantages for predicting

costs, allocating funds, and assessing training costs.

a. Class II and IV costs are relatively stable for units, regardless of their training posture. These classes represent a fixed operating cost, whether the unit is in garrison or at a training site. An exception is field construction, but this factor is easily costed and associated with a specific exercise. Other variations, such as individual equipment losses on field exercises, can be assessed through routine inspections. Class II and IV costs are manageable with the existing methodology.

b. Class III costs are directly related to training activity. Training events mean increased vehicle mileage or operating hours. Fuel costs are a function of these factors and can be computed if accurate mileage and operating hour figures are available. Obtaining valid mileage and operating hour data is dependent on an accurate reporting system, and is manageable with proper emphasis and supervision.

c. Class IX costs were the most elusive. The existing Class IX cost factors were the subject of controversy in V Corps and it was generally felt that they were inaccurate.

In May 1977, V Corps began the task of calculating new cost factors. This task was to be accomplished using selected units which would maintain detailed records for specific periods of time and training events. The data collection proccess was to take six months, followed by a period of analysis. The resultant cost factors were to be used in the existing formula for predicting Class IX costs.

The cost factor methodology outlined above has two drawbacks. First, the data collection process requires a

large investment in time and manpower. Second, cost factors are mean value estimates for an entire fleet. Possible difficulties in using expected values to predict Class IX costs are addressed in section D-Alternative Methodology II.

C. ALTERNATIVE METHODOLOGY I

In an effort to eliminate the lengthy data collection proceedure, the possibility of obtaining data from existing automatic data processing reports was analyzed. The Resource Management Expense Report (RMER) contains cost data for supplies and presents the data for each battalion. Other reports did not do this; therefore, the RMER was selected. The concept was to extract cost data from the RMER, compare it to unit training schedules, and assess supply costs as a result of the comparison.

1. Description of the Data

a. The RMER is a financial accounting system and records expenditures charged to a unit for a specific period of time. Class III costs are segregated from Class II, IV and IX costs. Since RMER is a financial accounting system, it assesses charges when items are delivered, not when they are requested. However, the system does provide a total dollar cost for all demands in the reporting period. This system was not implemented in the Corps' two divisions; therefore, the 11th Armored Cavalry Regiment, 41st Artillery Group and 42nd Artillery Group were selected as the test units.

b. Data was extracted for the period 22 June 1976 to 11 May 1977. This time interval covered eighteen

separate reporting periods from ten to thirty days in length. The cavalry squadron and artillery battalion were the basic elements for which data was collected, with a total of 11 battalion-sized units involved. The results of the data collection effort are in Appendix G.

2. Conclusions

a. The RMER report is not adequate for the purpose of assessing training costs to specific training events for the following reasons:

(1) there was a variable delay time for the delivery of items demanded through the supply system. Therefore, charges applied to a unit's account did not represent demands for the period in which delivery was made.

(2) the total demand figures were not segregated among Classes II, III, IV and IX.

(3) total demand costs exceeded total delivery costs for the entire period by a wide margin. Possible reasons for this are future cancelations of past orders, inability of the supply system to fill requests, and/or inaccuracies in the RMER.

b. Despite the above problems, the data does reveal some trends:

(1) the magnitude of demands increased when maintenance inspections were scheduled.

(2) a surge in demands was evident at the beginning of the fiscal year.

(3) some surges in demand appeared at the end of the fiscal year.

(4) delivery charges were sensitive to past demands (e.g., a thirty-day lag time was observed in some cases).

(5) the period from the end of November to the end of December showed marked decreases in demands. A substantial decrease in delivery charges for January followed. This was combined with an increase in demands for January.

c. The cycle of demands and deliveries appear to be less sensitive to major training exercises than they are to maintenance inspections and the fiscal cycle. This fact raises questions about the feasiblity of obtaining accurate cost factors if the period of analysis is only six months. This problem and the limitations of accurate cost factors are described in the following section.

D. ALTERNATE METHODOLOGY II

1. Hypothesis

There exist specific repair parts with failure rates which are too variable over time to allow accurate prediction of Class IX costs at the battalion level when using expected value cost factors.

2. Cost Factors as Expected Values

a. Cost factors are developed through analysis of repair-part cost and milage histories for particular vehicles. This type of data has many properties, including a mean and variance. The mean is a measurement of central tendency, while the variance is a measurement of the data's variability. In many cases, a mean value alone provides a very limited amount of information on the data it represents. For V Corps, it is crucial to know how the mean varied from old versus new vehicles and how it varied over time.

b. To demonstrate the situation, assume a cost factor for the M60A1 tank is the mean value of cost data for the entire M60A1 fleet over a ten year period. Consider the following examples:

(1) a battalion of new tanks operates for one year and its Class IX costs are totaled and compared with the dollar figure obtained using the DA cost factor. These values will not be equal if tanks, older than one year, incur higher repair costs than new tanks.

(2) a battalion of tanks, which closely reflects the composition of the entire fleet, operates for one month and its Class IX costs are totaled and compared with the dollar figure obtained using cost factors. They will not be equal if the repair costs for individual tanks, both old and new, vary from month to month.

3. Research Analysis Corporation Study

a. Subsequent to the introduction of the M60 tank to USAREUR the Research Analysis Corporation conducted a study of repair-parts requirements for the M60 tank and M113

armored personnel carrier [Ref. 5]. The data collected covered a two year period and involved 640 tanks and 707 armored personnel carriers. Some results of their analysis were as follows:

(1) many high-dollar-value components had failure rates that were dependent on mileage.

(2) replacement rates increased dramatically as mileage accumulated, especially after vehicles had been driven 2,000. miles.

b. The conclusion, therefore, is that part failures are a result of past usage. The cost of replacement should then be assessed to past training events. This assessment is difficult if the part is a tank track which has lasted two years. The Research Analysis Corporation study addressed individual vehicle failure rates. It did not consider the part-replacement rates by battalion. Since training costs are predicted using the battalion as a basis, it is important to know how the age and part-replacement rates for individual vehicles effect the aggregate replacement rates for each battalion. This aspect is addressed in the next section.

4. Additional Data

In June 1977, demand data for selected components of the M60 series tank were extracted from the Division Logistics System (DLOGS). Ten components were selected for the data collection effort. Their costs ranged from $31. to $209. An attempt was made to include items of high dollar value and high density on the tank. An example of such an item is the road wheel which costs $197., and has a density of 28 on each tank. The tank shoe was not included because

V Corps was undergoing a forced issue of a new type shoe. This issue seriously distorted normal demand data, thereby eliminating an item with high density (160 per tank) and high cost ($112. per shoe).

The data covered the 12 months prior to June 1977 and demands were recorded for the two six month periods in that time interval. Demands were sectioned by battalion. The six month demands were then tallied to produce each battalion's 12 month demands for the ten items.

The dates of manufacture or rebuild were also recorded for the V Corps tank fleet. This data was sectioned by battalion.

5. Analysis of the Data

The age data for V Corps' tank fleet and the demand data on the selected components were processed using a statistical package. Properties such as the mean, median, variance and standard deviation were obtained for each discrete set of data. The results are in Appendix H. Significant facts revealed by the data are described below.

a. Composition of Tank Battalions by Age

V Corps' armor battalion tank fleet consisted of 574 vehicles. The mean manufacture/rebuild date for the fleet was 1972.47 with a standard deviation of 2.38 years. The 3rd Armored Divisions' armor battalion tank fleet consisted of 306 vehicles. The mean manufacture/rebuild date for that portion of the Corps fleet was 1973.57 with a standard deviation of 1.34 years. The 8th Mechanized Infantry Division's armor battalion tank

fleet consisted of 268 vehicles. The mean manufacture/rebuild date for that portion of the Corps fleet was 1971.29 with a standard deviation of 2.68 years.

The six armor battalions in the 3rd Armor Division were very similar and reflected the age statisics for the division as a whole. The median dates of manufacture were 1973, 1974 and 1976 for three, two and one battalions, respectively.

The five armor battalions in the 8th Mechanized Infantry Division were very similar and reflected the age statistics for the division as a whole. The median dates of manufacture were: 1970 for two battalions; 1971 for two battalions, and 1973 for one battalion.

The battalions in the 3rd Armored Division had newer tanks than those in the 8th Mechanized Infantry Division's armor battalions. In addition, the 3rd Armored Division's battalions had tighter age frequency distributions than the 8th Mechanized Infantry Division's battalions. This fact is reflected in a greater standard deviation for the latter.

b. Demand Data for Tank Components

The six month demands and one year demands were analyzed separately. The analysis of the six month demands is presented first.

(1) The six month demands indicate variations in demands existed for the same battalion from one six month period to the next for the same item. Except in the case where demands were non-existent for both periods, all items showed significant fluctuations over time. For example, the

2/68 Armor Battalion requested five road wheels in the first period and 59 in the second. Most variations were not this pronounced; nonetheless, they were readily identifiable.

(2) The one year total demands indicate variations in demands existed among the battalions for the same item. All items showed significant fluctuations among the battalions. For example, the 4/69 Armor Battalion requested 161 road wheels in a 12 month period versus 13 for the 3/33 Armor Battalion.

6. Conclusions

a. The results presented in the previous sections indicate the following:

(1) Many components have failure rates which are dependent on accumulated road miles.

(2) An individual battalion may experience a high component failure rate during a training event or training cycle. This will occur if many of its vehicles reach accumulated mileages which are near or exceed the normal life of specific components.

(3) Armor battalions will incur component failure rates which are different from one year to the next. This fact is a result of variations in the ages of each battalion's tanks and the fact that many components have a normal life greater than one year.

(4) It is difficult to predict training costs using expected value cost factors when high density and high cost items such as road wheels have failure rates which are dependent on accumulated road mileage.

b. To circumvent the problems inherent in this situation, a different prediction and allocation methodology is required. To remove the built-in tendency for gross miscalculations when using expected value cost factors, selected high density and high cost items should be deleted from the present battalion management level. Management of funds for these items at the division or corps level would eliminate some of the variability in the battalion's Class IX dollar requirements. The intent is that the higher management level would use its knowledge of the mileage and component replacement histories of the fleet to predict future requirements.

In this manner a portion of the Class IX budget can be linked to a level of training, since increased training means increased mileage. An example of such a budget justification is as follows: V Corps' current level of training averages 100 miles per month per tank, resulting in a complete replacement of all tank tracks every two years, at a cost of 10 million dollars. A doubling of the training effort will halve the replacement period and double the yearly cost to $10 million.

VI. SCHEDULING MAJOR TRAINING AREA OPERATIONS

A. A COMPUTER ASSISTED APPROACH TO SCHEDULING

The requirement to develop and manage an annual MTA schedule combines the results of two types of decisions to produce a final product. The first type of decision drives the schedule to accomplish its ultimate goal of providing the training necessary to maintain the combat readiness of all V Corps elements. These decisions include providing adequate priorities to the proper units, insuring that an assigned training area satisfies the requirements generated by a particular type of training, and insuring that training is scheduled at a time which logically coincides with each battalion training program. These decisions are critical to management and depend on an understanding of the unique situation of each unit. The second type of decision involved in managing the MTA schedule is the static decision generated by the physical constraints of each MTA and by constraints imposed by higher headquarters. These decisions insure that training is scheduled only during authorized time periods, that density constraints for all training areas during all periods are satisfied, and that schedule information is disseminated to all appropriate elements. Density constaints refer to the maximum number of battalions that may occupy a MTA at any one time. These decisions are constrained and tedious but are necessary to insure the development of a feasible schedule.

A situation such as the one described above can be

managed effectively and efficiently by employing a computer assisted scheduling system which seperates the two types of decisions involved in developing the MTA schedule. The computer assisted system requires the manager to make the critical management decisions and employs a computer to resolve the constrained decisions, to consolodate all schedule information, and to present this information in a useful format.

B. DESCRIPTION OF THE COMPUTER ASSISTED SCHEDULING SYSTEM

1. General

The computer assisted scheduling system follows the basic methodology used by the V Corps G-3 section to manually prepare the FY 1977 MTA schedule. Specific modifications allow for computer assistance in the scheduling process. This section describes the system and uses an example based on the USAREUR FY 1978 MTA schedule [Ref. 6] to illustrate specific points.

2. Dissemination of Initial Scheduling Guidance

Once the initial MTA allocations are received from USAREUR, V Corps prepares this information for dissemination to its subordinate major headquarters. This preparation must include the classification of each allocation into one of six training categories and the division of all availability dates into specific training periods. The six training categories are as follows:

a. tank qualification gunnery, level one;

b. tank qualification gunnery, level two;

c. weapons firing;

d. artillery firing;

e. maneuver training;

f. support.

Note that aerial gunnery is not addressed because it represents a special case and is scheduled seperately. The length of time required to accomplish each type of training can be used to divide the aggregate allocation periods assigned by USAREUR into a list of specific training periods. Table VII uses the USAREUR FY 1978 MTA schedule and training duration information obtained from the V Corps G-3 to show a consolodated listing of the information needed to prepare the list of training periods. With this information a series of charts can be prepared to graphically show requesting units the areas which are available for each type of training. Examples of these charts , prepared from the FY 1978 MTA schedule, are shown in Tables VIII and IX. Period numbers should be assigned by training category and not by MTA. Table IX demonstrates this point as it lists the periods for maneuver training cronologically, regardless of major training area. These charts, supplemented by coordinating instructions, can be disseminated to all major commands to guide their planning of MTA training. The coordinating instructions may include information on the priority of specific training periods to a particular headquarters and any other guidance which will assist in the coordination of the schedule.

This system for disseminating initial planning

guidance is a method which insures that requesting units receive all the necessary scheduling infcrmation. Other systems are satisfactory as long as they enable each unit to submit a complete training request. The essential content of MTA training requests is discussed in the next section.

Table VII - AN EXAMPLE OF THE INFORMATION NEEDED TO DIVIDE USAREUR TRAINING ALLOCATIONS INTO TRAINING PERIODS.

TRAINING CATEGORY	INCLUSIVE TYPES OF TRAINING	DURATION (DAYS)	TYPE UNIT	FEASIBLE MTA
Tank Gunnery Level One	Tank Gunnery Level One	15	Armor, Armor Cav	Grafenwoehr
Tank Gunnery Level Two	Tank Gunnery Level Two	9	Armor, Armor Cav	Grafenwoehr Wildflecken
Weapons Firing	Individual and crew served weapons firing	Variable	Infantry, Engineers	Baumholder Grafenwoehr Wildflecken
Artillery Firing	Artillery anuual service practice	21	155 mm Arty 175 mm Arty 8 in Arty	Grafenwoehr
	Proficiency Firing	Variable		
Maneuver	ARTEP	21	All types	Baumholder Grafenwoehr Hohenfels Wildflecken
	Combined Arms Training	21		
	Multinational	Variable		
	Proficiency Training	Variable		

Table VIII - AN EXAMPLE OF AN INFORMATION CHART FOR TANK GUNNERY, LEVEL ONE PREPARED FROM THE FY 1978 USAREUR MAJOR TRAINING AREA SCHEDULE.

TYPE TRAINING: Tank Gunnery, level one

PERIOD	INCLUSIVE DATES	DURATION (DAYS)	AUTHORIZED DENSITY	MTA
1	4-19 OCT	15	3	GRAFENWOEHR
2	19 OCT-3 NOV	15	3	GRAFENWOEHR
3	3-17 NOV	15	3	GRAFENWOEHR
4	10-26 MAY	17	3	GRAFENWOEHR
5	26 MAY-12 JUN	17	3	GRAFENWOEHR
6	12-30 JUN	18	3	GRAFENWOEHR
7	12-28 SEP	17	3	GRAFENWOEHR
8	28 SEP-15 OCT	17	3	GRAFENWOEHR
9	15 OCT-1NOV	17	3	GRAFENWOEHR
10	1-19 NOV	18	3	GRAFENWOEHR

COORDINATING INSTRUCTIONS:

1. 11th ACR has priority in periods one, nine, and ten.

2. 3rd AD has priority in periods two, three, seven, and eight.

3. 8th ID has priority in periods four, five, and six.

Table IX - AN EXAMPLE OF AN INFORMATION CHART FOR MANEUVER TRAINING PREPARED FROM THE FY 1978 USAREUR MAJOR TRAINING AREA SCHEDULE.

TYPE TRAINING: Maneuver

PERIOD	INCLUSIVE DATES	DURATION (DAYS)	AUTHORIZED DENSITY	MTA
1	27 OCT-16 NOV	20	2	GRAFENWOEHR
2	21 NOV-12 DEC	21	3	BAUMHOLDER
3	12-21 DEC	10	3	BAUMHOLDER
4	16-22 DEC	7	7	HOHENFELS
5	2-19 JAN	18	3	BAUMHOLDER
6	1-20 MAR	20	7	HOHENFELS
7	15-27 MAR	13	2	WILDFLECKEN
8	16 MAR-3APR	19	2	BAUMHOLDER
9	20 MAR-10 APR	21	7	HOHENFELS
10	26 MAR-3 APR	8	1	BAUMHOLDER
11	26 APR-20 MAY	25	1	WILDFLECKEN
12	10-31 MAY	21	2	GRAFENWOEHR
13	1-8 JUN	8	1	GRAFENWOEHR
14	1-21 JUN	21	1	GRAFENWOEHR
15	15 JUN-9 JUL	25	2	BAUMHOLDER
16	1-9 JUL	9	1	BAUMHOLDER
17	20 JUN-8 JUL	19	7	HOHENFELS
18	8-27 JUL	19	7	HOHENFELS
19	7-30 AUG	24	2	BAUMHOLDER
20	8-31 AUG	24	2	WILDFLECKEN
21	1-28 SEP	28	1	WILDFLECKEN
22	12-30 SEP	19	1	GRAFENWOEHR
23	1-19 OCT	19	1	GRAFENWOEHR

COORDINATING INSTRUCTIONS:

1. Prior to requesting a training period, check that the capabilities of the corresponding MTA meet your training requirements.

2. Maneuver training priorities are as follows:

PRIORITY	TYPE TRAINING
1	ORTT/ARTEP (no fire)
2	ORTT/ARTEP (live fire)
3	Combined Arms Training (no fire)
4	Combined Arms Training (live fire)
5	All other exercises

3. <u>Submission of Training Requests</u>

The guidance provided by the V Corps training section will enable each major headquarters to plan its MTA training and to submit the necessary requests for training. Each request must follow a format which will permit the transfer of the information on these requests to the scheduling program; therefore, requests will include the following information:

a. unit designation;

b. major headquarters;

c. the type of unit requesting training;

d. the type of training requested;

e. the priority of the training;

f. the period requested;

g. the density requested;

h. the garrison location of the unit requesting training; and

i. the MTA requested.

During the selection process, requesting units should be aware of two important considerations. First, if one wishes to minimize the total movement cost generated by the training, and if a feasible training period is available at more than one MTA, then the closest MTA should be selected.

This situation will occur most frequently while selecting maneuver training where training allocations at more than one MTA frequently overlap or coincide. Second, the scheduler must insure that the MTA possesses the facilities necessary for the projected training. This consideration is again most critical for maneuver training where the capability to perform live fire or artillery supported training may be a function of the training area.

4. Compiling and Maintaining the Major Training Area Schedule

Once the requests for training are submitted to V Corps, the task of compiling these requests into a feasible schedule begins. At this point the management decisions have been made, period numbers have been assigned to training dates, and appropriate priorities have been given to the most critical training. The next step is to prepare a schedule subject to the density constraints imposed by USAREUR. Remember, density constraints designate the maximum number of battalion sized elements that may occupy a MTA at any one time. The preparation of this schedule can be accomplished quickly and efficiently by an automated process. The V Corps training section must prepare the input for the V Corps MTA Scheduling Program[1] according to the User's Guide found at Appendix I. The program will produce a feasible schedule or identify overscheduled periods and/or errors found on input cards. Training managers can then

---

[1]Due to the excessive length of the program listing, it is not included within the thesis. A copy of the program listing may be obtained from the authors or from Prof. Samuel H. Parry. Please send requests to the appropriate mailing address which may be found in the Initial Distribution List on page 149.

request additional densities, adjust training priorities, or take whatever action is necessary to resolve the conflicts identified by the scheduling routine. Once the input information is adjusted, the program can be run again in an effort to gain a feasible solution. To establish the initial schedule, this process can be repeated as often as necessary. Subsequent changes may be made by adding or deleting the appropriate input data.

C. THE DECISION LOGIC FOR THE SCHEDULING PROGRAM

The decision logic employed by the scheduling program is most influenced by the priorities assigned to each training request. A schedule is maintained for every one of the six major training categories and as each request is read it is processed through the complete scheduling routine. If the requested density for the indicated period is available, the unit is scheduled immediately and the available density for that period is appropriately reduced. Each scheduled unit is ordered in a matrix by priority and then by movement cost from its garrison location to the MTA. Thus, the bottom line on each schedule represents the training with the lowest priority and the highest movement cost. If, when a request is read, the desired training period is full, then the priority of the new request is compared to the priority of the last request found on the scheduled training list. If the new request has a higher priority, the bottom request on the training schedule is removed and placed into an unscheduled training list. The new request is then placed into the schedule in a position dictated by its priority and movement cost. If a new request has a lower priority than that of the bottom scheduled request, the new request is placed in the unscheduled training list. If the new request and the lowest priority scheduled request have equal

priorities, then the one with the least movement cost is given a position on the schedule and the other is placed on the unscheduled training list. Thus, movement cost is used as the criterion which breaks ties in the event of a full schedule. This decision rule may be overridden, of course, by assigning any request a sufficiently high priority.

D. THE CAPABILITIES OF THE V CORPS MAJOR TRAINING AREA SCHEDULING PROGRAM

The MTA Scheduling Program provides the user with three seperate management aids. First, the program scans each input constraint and request for errors which will cause the program to function improperly. An error on an input constraint indicates that an infeasible number of periods is being assigned to a training category or that an infeasible density is being assigned to some period. An error of this type will abort the execution of the program and will print an error message. This error message will explain why the program was terminated and what the user must do to correct the error. an example of this type message is as follows:

```
******PROGRAM NOT RUN******
AN INPUT CONSTRAINT IS OUT OF RANGE.
THE ERROR IS ON THE DATA CARD WHICH ASSIGNS  THE  NUMBER  OF
PERIODS TO EACH TRAINING CATEGORY.
CHECK THE VALUE AND FORMAT OF EACH ENTRY.
```

An error on a training request indicates that a request contains an invalid entry. This type of error will not cause the execution of the program to terminate; however, any request containing an error will not be processed through the scheduling routine. In this case, the first page of program output is a listing of each request with an invalid

entry to include a message indicating the specific location of the error. If an error listing is not printed, then every entry has satisfied the validity criteria established for the request data. An example of this feature is shown here:

```
THE FOLLOWING REQUEST HAS AN INVALID TYPE UNIT ENTRY:
2-68      2     13      2      1      1      1      1      4
```

Appendix I explains that the "TYPE UNIT" entry is the third entry on a request card and that the feasible codes for this input category are the numerals from one to twelve. Therefore, the number thirteen found in the above example is identified as an invalid entry. Remember, requests generating an error message will not be scheduled.

Next, the program provides a summary of the pertinent statistics generated by the schedule. These figures are presented by training category and period number. For each period, the program prints the authorized density, the number of units scheduled, the remaining available density, and the number of unscheduled requests. Figure 3 shows a portion of this summary generated using information from the FY 1978 USAREUR schedule. This example presents the statistics only for the tank gunnery training categories. A complete printout will show the figures for all six training categories. The meaning of the numbers in each column is evident from the column headings. One feature of the system is demonstrated by the figures for period twelve, tank gunnery,level two. Notice that column three shows no units scheduled, column four shows that one density is still available, and column five shows one unit not scheduled because of density constraints. In this case, the one unit requesting training asked for a density of two; however, only one density was authorized during this period. As a result the unit was not scheduled.

The statistical summary is followed by a listing of the scheduled and unscheduled training. These listings are available in three seperate formats, and the user dictates which format, or group of formats, will be printed. The formats are designed to assist planners at varying levels of the chain of command.

Option One prints the schedule by major headquarters. The training is further grouped by unit designator and type training. This option should be most useful to the training managers at division, group, brigade, or batallion level. Figure 4 presents an example of the schedule format which is printed using Option One. This figure lists the training scheduled for three units of the 3rd Armor Division. Notice that in this format, once a unit designator is printed, all of the training scheduled for that unit will be listed regardless of training area. For each approved training exercise, the schedule identifies the training area, the period during which the training will take place, the authorized unit density for the training, and the priority assigned to each training event. This option also produces a similar printout for training which was unable to be scheduled.

Option Two prints the schedule for each major headquarters by MTA. This option can assist the V Corps staff in planning for MTA range conferences and in monitoring the overall training situation. Figure 5 shows an extract from a schedule prepared using Option Two. The section of the schedule shown here lists three units from the 8th Infatry Division with training scheduled at the Baumholder MTA. In this format all training scheduled for areas other than Baumholder will be listed in a seperate section under the appropriate training area heading. The schedule information presented with this option is identical to the information obtained from Option One. It is simply

presented in a different format. Additionally, Option Two will print a listing of all unscheduled training.

Option Three prints the schedule by MTA and by type training. A copy of this schedule can be forwarded to USAREUR, to the 7th Army Training Center, and to the individual training area commands as a summary of projected V Corps training. Figure 6 gives an example of this format which lists training at the Grafenwoehr MTA. Due to space limitations only five of the six training categories appear; however, in the actual printout all six categories will be printed. This option generates schedule information in this form for all four MTAs. If any training category is not scheduled for a given MTA, the heading for that category will not appear on the schedule printout. Notice that each unit is identified with its major headquarters and that each training category is ordered by period. Notice also that within each period the training is ordered by priority. This feature is demonstrated in the weapons firing training category in Figure 6. The first four units all have training scheduled during period one; therefore, they are ordered by priority. The first two units listed, the 2-36 and the 3-36/3rd AD, have priority one; the third unit listed, the 1-36/3rd AD, has priority two; and the fourth unit, the 58/11th ACR, has priority three.

Operation of the scheduling program does not require the scheduler to have previous computer programming experience. Complete instructions describing the preparation of the input cards and the mechanics of running the program are given in the User's Guide for the V Corps MTA Scheduling Program(Appendix I). The program is written in FORTRAN IV programming language and requires a computer system with a 230,000 byte core storage capacity. The computer assets available to V Corps are capable of satisfying these requirements. The total Central Processing Unit time

required for one run is less than three minutes. The system does require the user to collect and process the input information required by the program. It is difficult to predict the extent of this effort without some field testing; however, considering the time and effort required to manually produce and maintain the FY 1977 MTA schedule, a well managed computer assisted scheduling system should reduce the scheduling time requirement considerably.

E. SUMMARY

The computer assisted scheduling system is a feasible alternative to the completely manual system employed by V Corps in FY 1977. This system provides the training officer with the capability to manage the training schedule according to existing priorities, while relieving him of the time consuming task of continually checking training area constraints. The program prints the schedule in a form which can assist in the effective management of the MTA training schedule and facilitate the dissemination of the schedule information. Finally, the system is immediately implementable since the computer hardware required to support the system is satisfied by existing V Corps computer assets.

```
************************************
************************************

 V CORPS MTA SCHEDULING STATISTICS

************************************
************************************
```

TYPE_TRAINING:_TANK_GUNNERY,_LEVEL_1.

PERIOD NUMBER	AUTHORIZED DENSITY	NUMBER OF UNITS SCHEDULED	REMAINING AVAILABLE DENSITY	NUMBER OF UNITS NOT SCHEDULED BECAUSE OF DENSITY CONSTRAINTS
1	3	3	0	4
2	3	2	1	0
3	3	1	2	0
4	3	3	0	0
5	3	2	0	1
6	3	0	3	0
7	3	2	0	0
8	3	0	3	0
9	3	0	3	0
10	3	0	3	0

TYPE_TRAINING:_TANK_GUNNERY,_LEVEL_2.

PERIOD NUMBER	AUTHORIZED DENSITY	NUMBER OF UNITS SCHEDULED	REMAINING AVAILABLE DENSITY	NUMBER OF UNITS NOT SCHEDULED BECAUSE OF DENSITY CONSTRAINTS
1	2	1	1	0
2	2	0	2	0
3	1	1	0	1
4	1	1	0	1
5	1	0	1	0
6	1	0	1	0
7	1	1	0	1
8	1	1	0	0
9	1	1	0	0
10	1	1	0	0
11	1	0	1	0
12	1	0	1	1
13	1	1	0	0
14	1	1	0	0

Figure 3 - AN EXAMPLE OF THE STATISTICS SUMMARY PRINTED BY THE V CORPS MAJOR TRAINING AREA SCHEDULING PROGRAM

****

SCHEDULED MTA TRAINING FOR: 3RD ARMORED DIVISION.

****

UNIT DESIGNATOR: 3-32

TYPE TRAINING: TANK GUNNERY, LEVEL 1.

MTA	PERIOD	DENSITY	PRIORITY
GRAFENWOEHR	1	1	1
GRAFENWOEHR	7	2	2

TYPE TRAINING: FIELD MANEUVERS.

MTA	PERIOD	DENSITY	PRIORITY
HOHENFELS	9	1	1

UNIT DESIGNATOR: 2-32

TYPE TRAINING: TANK GUNNERY, LEVEL 1.

MTA	PERIOD	DENSITY	PRIORITY
GRAFENWOEHR	7	1	1

TYPE TRAINING: FIELD MANEUVERS.

MTA	PERIOD	DENSITY	PRIORITY
HOHENFELS	9	2	2

UNIT DESIGNATOR: 2-33

TYPE TRAINING: TANK GUNNERY, LEVEL 1.

MTA	PERIOD	DENSITY	PRIORITY
GRAFENWOEHR	1	1	1
GRAFENWOEHR	1	1	1

TYPE TRAINING: TANK GUNNERY, LEVEL 2.

MTA	PERIOD	DENSITY	PRIORITY
WILDFLECKEN	7	1	1

Figure 4 - AN EXAMPLE OF SCHEDULE FORMAT OPTION ONE PRINTED BY THE V CORPS MAJOR TRAINING AREA SCHEDULING PROGRAM

```
********************************************************************************
     SCHEDULED TRAINING AT THE BAUMHOLDER  MTA FOR: 8TH INFANTRY DIVISION.
********************************************************************************

------------------------------------------------------------

UNIT_DESIGNATOR:_1-68
---------------------

TYPE_TRAINING:_FIELD_MANEUVERS._

PERIOD      DENSITY      PRIORITY
  8            1             1

------------------------------------------------------------

UNIT_DESIGNATOR:_2-68
---------------------

TYPE_TRAINING:_FIELD_MANEUVERS._

PERIOD      DENSITY      PRIORITY
  15           1             2

------------------------------------------------------------

UNIT_DESIGNATOR:_5-68
---------------------

TYPE_TRAINING:_FIELD_MANEUVERS._

PERIOD      DENSITY      PRIORITY
  19           1             2

------------------------------------------------------------
```

Figure 5 - AN EXAMPLE OF SCHEDULE FORMAT OPTION TWO PRINTED BY THE V CORPS MAJOR TRAINING AREA SCHEDULING PROGRAM

****
SCHEDULED TRAINING AT THE GRAFENWOEHR MTA.
****

TYPE_TRAINING:_TANK_GUNNERY,_LEVEL_1.

UNIT	HEADQUARTERS	PERIOD	DENSITY	PRIORITY
2-33	3RD AD	1	1	1
3-32	3RD AD	1	1	1
2-33	3RD AD	1	1	1
1-11	11TH ACR	2	1	1
3-11	11TH ACR	2	1	1
2-11	11TH ACR	3	1	1
1-70	BDE 76	4	1	1
1-68	8TH ID	4	1	1
2-68	8TH ID	4	1	1
2-68	8TH ID	5	2	1
4-69	8TH ID	5	1	2
2-32	3RD AD	7	1	1
3-32	3RD AD	7	2	2

TYPE_TRAINING:_TANK_GUNNERY,_LEVEL_2.

UNIT	HEADQUARTERS	PERIOD	DENSITY	PRIORITY
3-68	8TH ID	1	1	1

TYPE_TRAINING:_WEAPONS_FIRING.__

UNIT	HEADQUARTERS	PERIOD	DENSITY	PRIORITY
2-36	3RD AD	1	1	1
3-36	3RD AD	1	1	1
1-36	3RD AD	1	1	2
58	11TH ACR	1	1	3
23	3RD AD	3	1	1

TYPE_TRAINING:_ARTILLERY_FIRING.

UNIT	HEADQUARTERS	PERIOD	DENSITY	PRIORITY
2-92	42ND FA	1	1	1
3-16	8TH ID	1	1	1
2-83	41ST FA	2	1	1
1-40	3RD AD	2	1	1
2-75	41ST FA	2	1	3
1-83	8TH ID	3	1	1
2-81	8TH ID	3	3	11
1-2	8TH ID	4	1	1
2-27	3RD AD	5	2	1
2-20	BDE 76	5	1	1
2-6	3RD AD	6	1	1
2-3	3RD AD	6	1	1
6-9	42ND FA	7	1	1
2-5	41ST FA	8	1	1

TYPE_TRAINING:_FIELD_MANEUVERS._

UNIT	HEADQUARTERS	PERIOD	DENSITY	PRIORITY
1-36	3RD AD	1	1	1
1-33	3RD AD	12	1	1
2-92	42ND FA	13	1	2
3-33	3RD AD	14	1	1

Figure 6 - AN EXAMPLE OF SCHEDULE FORMAT OPTION THREE PRINTED BY THE V CORPS MAJOR TRAINING AREA SCHEDULING PROGRAM

VII. CONCLUSIONS

A. MOVEMENT

The movement of tanks to MTAs with heavy equipment transporters is the best alternative for reducing rail movement costs. Stake and platform trucks and road marching are only marginally effective for reducing rail costs. Prepositoning one battalion-size set of M60A1 tanks at Grafenwoehr for level two gunnery is the best prepositioning option; however, it is not as practical or effective in reducing rail movement costs as the maximum use of HET assets.

B. SUPPLY COSTS

Expected value cost factors are inadequate for predicting supply costs and allocating supply funds at the battalion level over short periods of time. This is due to the small sample size of vehicles at the battalion level and the fact that the life expectancy for many components is greater than one year. Larger sample sizes and time periods are needed to give cost factor predictions better accuracy. Removing selected high density and high cost repair-parts from the battalion management level will increase the stability of battalion level Class IX costs and provide a means for linking a specific level of training to certain Class IX costs.

C. SCHEDULING

The computer assisted scheduling system, described in Chapter IV , is a feasible alternative to the completely manual system employed by V Corps in FY 1977. This system provides the training officer with the capability to manage the training schedule according to existing priorities, while relieving him of the time consuming task of continually checking training area constraints. The program prints the schedule in a form which can assist in the effective management of the MTA training schedule and facilitate the dissemination of the schedule information. Finally, the system is immediately implementable since the computer hardware required to support the system is satisfied by existing V Corps computer assets.

APPENDIX A

COMPUTING RAIL MOVEMENT COSTS

A. REFERENCES

1. 4th Transportaion Brigade Pamphlet 55-1, dated 1 March 1976, w/changes 1-3. European Freight Traffic Management Handbook [Ref. 7].

2. Convention Between the Deutsche Bundesbahn and the United States, effective 1 January 1964, w/amendments 1-31 [Ref. 3].

B. BASIC FORMULA FOR NORMAL SIZE EQUIPMENT

1. (DM rate x Vehicle Wt. in 100 kgs) + 3.2 DM = DM Cost

2. Notes:

a. All manuever trains are considered M3 class.

b. DM refers to Deutsche Marks. The DM rate is obtained from Annex A, reference A1.

c. For 4 and 6 axle cars, the weight minima

are: 19.5, 26., and 32.5 metric tons at the 15., 20. and 25. metric ton rates respectively.

d. 3.2 DM surcharge is added for all destinations within the FRG.

e. The vehicle weight in 100 kgs is obtained from Annex B, reference A1.

f. The metric tonnage is obtained from the M1 shipping weight column of Annex B, reference A1.

C. BASIC FORMULA FOR OVERSIZED EQUIPMENT

1. (DM rate x Vehicle wt. in 100 kgs) + 3.2 DM = Y

Y + (.1 x Y) = DM Cost

D. SPECIAL CONSIDERATIONS

1. Additional charges can occur and any shipment might incur some of the following:

a. demurrage fees,

b. re-spotting fees,

c. transfer fees,

d. spotting fees,

e. station consignment fees.

2. A special routing may be required for oversized loads which can increase the rail distance traveld by the entire train.

3. The total additional cost due to the above expenses will vary and depend on the situation. There is no fixed percent that can be added to the basic cost to account for these charges; however, current estimates range from five to fifteen percent. A fixed accounting procedure should be developed which will allow each battalion to accurately estimate these costs.

APPENDIX B

BATTALION COST MATRICES($)

This appendix contains the rail movement cost matrices for six different types of battalions. The matrices were generated by totaling the individual vehicle shipping costs of all tracked vehicles in each battalion. Every entry represents the dollar cost (2.32 D M per dollar) to ship the battalion by rail from the garrison locations (listed vertically) to the training sites (listed horizontally). Each entry is a one-way shipping cost.

Table X - COST MATRIX($)--ARMOR BN w/M60A1

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	40296.	61121.	54415.	57183.	30822.
BAD HERSFELD	59805.	67237.	62283.	63598.	43645.
BAD KISSIGEN	57183.	48745.	45977.	41894.	28355.
BAD KREUZNACH	22125.	72483.	68543.	57183.	47428.
BAUMHOLDER	0.	80348.	76411.	76411.	57183.
BUEDINGEN	45977.	64905.	58498.	61121.	28355.
BUTZBACH	43645.	67237.	62283.	63598.	38545.
DARMSTADT	35196.	64905.	59805.	61121.	36794.
FRANKFURT	35922.	64905.	59805.	61121.	35196.
FRIEDBURG	41894.	65921.	61121.	62283.	35922.
FULDA	52964.	62283.	55732.	57183.	24562.
GELENHAUSEN	43645.	63598.	57183.	59805.	26458.
GIESSEN	47428.	64132.	64905.	65921.	38545.
GRAFENWOEHR	80339.	0.	35922.	19963.	59805.
HANAU	39415.	62283.	55732.	57183.	29951.
HOHENFELS	76411.	35922.	0.	31849.	52964.
IDAR OBERSTEIN	12120.	78453.	74513.	74513.	54415.
MAINZ	30822.	68543.	63598.	63598.	41022.
MANNHEIM	37819.	69715.	62283.	64905.	45977.
VILSECK	76411.	19963.	31849.	0.	55732.
WIESBADEN	30822.	68543.	63598.	64905.	41022.
WILDFLECKEN	57183.	59805.	52964.	56670.	0.

Table XI - COST MATRIX($)--MECHANIZED INFANTRY BN

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	14132.	21418.	19045.	20016.	10787.
BAD HERSFELD	20937.	23556.	21811.	22291.	15299.
BAD KISSIGEN	20016.	17094.	16123.	14671.	9955.
BAD KREUZNACH	8002.	25400.	23997.	20016.	16613.
BAUMHOLDER	0.	28132.	26763.	26763.	20016.
BUEDINGEN	16123.	22732.	20496.	21418.	9955.
BUTZBACH	15299.	23556.	21811.	22291.	13504.
DARMSTADT	12337.	22732.	20937.	21418.	12876.
FRANKFURT	12582.	22732.	20937.	21418.	12337.
FRIEDBURG	14671.	23075.	21418.	21811.	12582.
FULDA	18555.	21811.	19526.	20016.	8606.
GELENHAUSEN	15299.	22291.	20016.	20937.	9277.
GIESSEN	16613.	24137.	22732.	23075.	13504.
GRAFENWOEHR	28125.	0.	12582.	7842.	20937.
HANAU	13798.	21811.	19526.	20016.	10493.
HOHENFELS	26763.	12582.	0.	11171.	18555.
IDAR OBERSTEIN	7430.	27489.	26085.	26085.	19045.
MAINZ	10787.	23997.	22291.	22291.	14377.
MANNHEIM	13259.	24429.	21811.	22732.	16123.
VILSECK	26763.	7842.	11171.	0.	19526.
WIESBADEN	10787.	23997.	22291.	22732.	14377.
WILDFLECKEN	20016.	20937.	18555.	23243.	0.

Table XII - COST MATRIX($)--ARMORED CAVALRY SQUADRON w/M551A1

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	35093.	53225.	47379.	49792.	26835.
BAD HERSFELD	52070.	58544.	54235.	55379.	38011.
BAD KISSIGEN	49792.	42454.	40041.	36484.	24703.
BAD KREUZNACH	19449.	63121.	59677.	49792.	41298.
BAUMHOLDER	0.	70008.	66532.	66532.	49792.
BUEDINGEN	40041.	56513.	50936.	53225.	24703.
BUTZBACH	38011.	58544.	54235.	55379.	33567.
DARMSTADT	30650.	56513.	52070.	53225.	32041.
FRANKFURT	31279.	56513.	52070.	53225.	30650.
FRIEDBURG	36484.	57399.	53225.	54235.	31279.
FULDA	46123.	54235.	48535.	49792.	21431.
GELENHAUSEN	38011.	55379.	49792.	52070.	23043.
GIESSEN	41298.	56911.	56513.	57399.	33567.
GRAFENWOEHR	69943.	0.	31279.	17781.	52070.
HANAU	34319.	54235.	48535.	49792.	26084.
HOHENFELS	66532.	31279.	0.	27744.	46123.
IDAR OBERSTEIN	12696.	68316.	64872.	64872.	47379.
MAINZ	26835.	59677.	55379.	55379.	35722.
MANNHEIM	32939.	60709.	54235.	56513.	40041.
VILSECK	66532.	17781.	27744.	0.	48535.
WIESBADEN	26835.	59677.	55379.	56513.	35722.
WILDFLECKEN	49792.	52070.	46123.	50482.	0.

Table XIII - COST MATRIX($)--175MM SP FIELD ARTILLERY BN

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	7437.	11277.	10030.	10543.	5678.
BAD HERSFELD	11025.	12401.	11487.	11734.	8054.
BAD KISSIGEN	10543.	8999.	8487.	7727.	5239.
BAD KREUZNACH	4193.	13376.	12636.	10543.	8746.
BAUMHOLDER	0.	14840.	14092.	14093.	10543.
BUEDINGEN	8487.	11969.	10790.	11277.	5239.
BUTZBACH	8054.	12401.	11487.	11734.	7110.
DARMSTADT	6493.	11969.	11025.	11277.	6783.
FRANKFURT	6623.	11969.	11025.	11277.	6493.
FRIEDBURG	7727.	12154.	11277.	11487.	6623.
FULDA	9771.	11487.	10283.	10543.	4574.
GELENHAUSEN	8054.	11734.	10543.	11025.	4881.
GIESSEN	8746.	12764.	11969.	12154.	7110.
GRAFENWOEHR	14810.	0.	6623.	3863.	11025.
HANAU	7265.	11487.	10283.	10543.	5523.
HOHENFELS	14093.	6623.	0.	5881.	9771.
IDAR OBERSTEIN	2715.	14475.	13735.	13735.	10030.
MAINZ	5678.	12636.	11734.	11734.	7567.
MANNHEIM	6980.	12864.	11487.	11969.	8487.
VILSECK	14093.	3863.	5881.	0.	10293.
WIESBADEN	5678.	12636.	11734.	11969.	7567.
WILDFLECKEN	10543.	11025.	9771.	11849.	0.

Table XIV - COST MATRIX($)--8 IN SP FIELD ARTILLERY BN

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	7191.	10910.	9713.	10208.	5499.
BAD HERSFELD	10674.	12000.	11119.	11351.	7790.
BAD KISSIGEN	10208.	8700.	8206.	7478.	5060.
BAD KREUZNACH	4065.	12940.	12234.	10208.	8464.
BAUMHOLDER	0.	14362.	13639.	13639.	10208.
BUEDINGEN	8206.	11584.	10440.	10910.	5060.
BUTZBACH	7790.	12000.	11119.	11351.	6879.
DARMSTADT	6280.	11584.	10674.	10910.	6568.
FRANKFURT	6410.	11584.	10674.	10910.	6280.
FRIEDBURG	7478.	11768.	10910.	11119.	6410.
FULDA	9454.	11119.	9949.	10208.	4428.
GELENHAUSEN	7790.	11351.	10208.	10674.	4720.
GIESSEN	8464.	11650.	11584.	11768.	6879.
GRAFENWOEHR	14339.	0.	6410.	3737.	10674.
HANAU	7034.	11119.	9949.	10208.	5344.
HOHENFELS	13639.	6410.	0.	5685.	9454.
IDAR OBERSTEIN	2621.	14005.	13299.	13299.	9713.
MAINZ	5499.	12234.	11351.	11351.	7320.
MANNHEIM	6750.	12445.	11119.	11584.	8206.
VILSECK	13639.	3737.	5685.	0.	9949.
WIESBADEN	5499.	12234.	11351.	11584.	7320.
WILDFLECKEN	10208.	10674.	9454.	10125.	0.

Table XV - COST($) MATRIX--155MM SP FIELD ARTILLERY BN

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	10447.	15866.	14128.	14853.	7985.
BAD HERSFELD	15518.	17443.	16178.	16499.	11327.
BAD KISSIGEN	14853.	12652.	11928.	10882.	7357.
BAD KREUZNACH	5904.	18828.	17787.	14853.	12304.
BAUMHOLDER	0.	21010.	19837.	19837.	14853.
BUEDINGEN	11928.	16843.	15174.	15866.	7357.
BUTZBACH	11327.	17443.	16178.	16499.	10002.
DARMSTADT	9122.	16843.	15518.	15866.	9557.
FRANKFURT	9310.	16843.	15518.	15866.	9122.
FRIEDBURG	10882.	17122.	15866.	16178.	9310.
FULDA	13752.	16178.	14477.	14853.	6442.
GELENHAUSEN	11327.	16499.	14853.	15518.	8852.
GIESSEN	12304.	18104.	16843.	17122.	10002.
GRAFENWOEHR	20845.	0.	9310.	5442.	15518.
HANAU	10222.	16178.	14477.	14853.	7765.
HOHENFELS	19837.	9310.	0.	8269.	13752.
IDAR OBERSTEIN	4252.	20373.	19332.	19332.	14128.
MAINZ	7985.	17787.	16499.	16499.	10635.
MANNHEIM	9814.	18104.	16178.	16843.	11928.
VILSECK	19837.	5442.	8269.	0.	14477.
WIESBADEN	7985.	17787.	16499.	16843.	10635.
WILDFLECKEN	14853.	15518.	13752.	14631.	0.

APPENDIX C

RAIL COST ($) SUMMARY

This appendix contains a statistical summary of the rail movement matrices generated for V Corps. Approximately 150 matrices were generated and included one matrix for each vehicle and feasible loading configuration. In addition, a matrix was generated for each battalion type and the separate type vehicles in the battalions. The tables which follow contain the mean, median, standard deviation, maximum and minimum for each matrix.

RAIL COST ($) SUMMARY

Table XVI - INDIVIDUAL VEHICLES

VEHICLE	LOADING CONFIGURATION	MEAN	S.D.	MEDIAN	MIN.	MAX.
M60A1	1 per 4 axle	778.	227.	837.	163.	1,777.
M60A2	1 per 4 axle	861.	251.	927.	180.	1,302.
M60AVLB	1 per 6 axle	650.	190.	700.	136.	984.
M728	1 per 4 axle	829.	242.	893.	174.	1,255.
M551	2 per 6 axle	243.	70.	260.	69.	366.
M551	1 per 4or6 axle	363.	105.	390.	107.	549.
M55A1	2 per 6 axle	267.	77.	287.	69.	403.
M55A1	1 per 4or6 axle	400.	116.	429.	118.	604.
M88	1 per 4 axle	863.	252.	929.	181.	1,305.
M578	2 per 6 axle	424.	124.	456.	89.	641.
M578	1 per 4 axle	509.	149.	547.	124.	775.
M113A1	3 per 4 axle	161.	46.	172.	69.	242.
M113A1	2 per 2 axle	183.	53.	197.	69.	279.
M113A1	1 per 2,4,or6 axle	335.	96.	360.	135.	506.
M548	3 per 4 axle	142.	40.	152.	69.	215.
M548	2 per 2 axle	177.	51.	190.	69.	267.
M548	1 per 2,4,or6 axle	259.	74.	278.	105.	390.
M577	3 per 4 axle	179.	52.	192.	69.	270.
M577	2 per 2 axle	179.	52.	192.	69.	270.
M125A1	3 per 4 axle	151.	43.	162.	69.	227.
M125A1	2 per 2 axle	172.	49.	185.	69.	262.

Table XVI (Continued)

VEHICLE	LOADING CONFIGURATION	MEAN	S.D.	MEDIAN	MIN.	MAX.
M125A1	1 per 2,4,or6 axle	315.	90.	338.	127.	473.
M106	3 per 4 axle	146.	41.	156.	69.	220.
M106	2 per 2 axle	167.	48.	179.	69.	253.
M106	1 per 2,3,or4 axle	304.	87.	327.	123.	459.
M106A1	3 per 4 axle	161.	46.	172.	69.	242.
M106A1	2 per 2 axle	183.	53.	197.	69.	279.
M106A1	1 per 2,3,or4 axle	335.	96.	360.	135.	506.
M132	3 per 4 axle	173.	50.	186.	69.	262.
M132	2 per 2 axle	173.	50.	186.	69.	262.
M114A1	3 per 4 axle	137.	38.	146.	69.	207.
M114A1	2 per 2 axle	170.	49.	182.	69.	257.
HD16M	2 per 6 axle	389.	114.	419.	82.	59.
HD16M	1 per 4 axle	467.	136.	503.	114.	712.
M107	1 per 6 axle	489.	143.	524.	103.	736.
M55	1 per 4 axle	737.	215.	793.	155.	111.
M110	2 per 6 axle	432.	126.	465.	91.	654.
M110	1 per 4 axle	519.	152.	558.	127.	791.
M109	2 per 6 axle	415.	121.	447.	87.	628.
M109A1	1 per 6 axle	498.	145.	536.	122.	759.
M52	2 per 6 axle	398.	116.	428.	84.	601.
M52	1 per 4 axle	478.	139.	514.	117.	728.
M108	2 per 6 axle	363.	106.	391.	76.	549.
M108	1 per 4 axle	383.	112.	410.	81.	577.
XM163	3 per 4 axle	179.	52.	192.	69.	270.

Table XVI (Continued)

VEHICLE	LOADING CONFIGURATION	MEAN	S.D.	MEDIAN	MIN.	MAX.
XM163	2 per 2 axle	179.	52.	192.	69.	270.
XM163	1 per 2,4,6 axle	255.	74.	274.	76.	385.

Table XVII - ARMOR BATTALION W/M60A1

VEHICLES	NUMBER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M60A1	54	$42,022.	$12,259.	$45,238.	$8,830.	$63,558.
M88	5	4,313.	1,258.	4,644.	905.	6,525.
M578	2	847.	247.	912.	177.	1,281.
M60AVLB	2	1,300.	379.	1,400.	273.	1,967.
M106A1	4	666.	190.	715.	275.	1,013.
M577	7	1,254.	360.	1,342.	482.	1,886.
M113A1	13	2,096.	596.	2,239.	896.	3,147.
M730	4	645.	183.	689.	275.	968.
	TOTAL	$53,314.	$15,468.	$57,182.	$12,119.	$80,348.

Table XVIII - ARMOR BATTALION W/M60A2

VEHICLES	NUMBER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M60A2	54	$46,497.	$13,567.	$50,005.	$9,764.	$70,329.
M88	5	4,313.	1,258.	4,644.	905.	6,525.
M578	2	847.	247.	912.	177.	1,281.
M60AVLB	2	1,300	379.	1,400.	273.	1,967.
M106A1	4	666.	190.	715.	275.	1,013.
M577	7	1,254.	360.	1,342.	482.	1,886.
M113A1	13	2,096.	596.	2,239.	896.	3,147.
M730	4	645.	183.	689.	275.	968.
	TOTAL	$57,622.	$16,775.	$62,000.	$13,053.	$87,119.

Table XIX - MECHANIZED INFANTRY BATTALION

VEHICLES	NUMBER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M113A1	54	$9,376.	$2,665.	$10,018.	$3,999.	$14,080.
M730	22	3,570.	1,015.	3,815.	1,517.	5,363.
M125A1	9	1,363.	384.	1,455.	620.	2,044.
M577	7	1,254.	360.	1,342.	482.	1,886.
M106	4	606.	170.	648.	275.	912.
M578	6	2,541.	741.	2,736.	533.	3,844.
	TOTAL	$18,713.	$5,334.	$20,015.	$7,430.	$28,132.

Table XX - ARMORED CAVALRY SQUADRON W/M551A1

VEHICLES	NUMBER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M551A1	54	$14,399.	$4,178.	$15,493.	$3,724.	$21,762.
M60A1	17	13,229.	3,859.	14,241.	2,780.	20,009.
M113A1	35	5,689.	1,618.	6,080.	2,413.	8,548.
M577	11	1,972.	567.	2,109.	758.	2,964.
M106A1	9	1,319.	369.	1,407.	620.	1,977.
M548	6	852.	237.	911.	413.	1,291.
M109A1	6	2,989.	872.	3,217.	731.	4,555.
M60AVLB	3	1,951.	569.	2,100.	410.	2,951.
M88	2	1,725.	503.	1,857.	362.	2,610.
M578	5	2,203.	642.	2,371.	480.	3,338.
	TOTAL	$46,331.	$13,404.	$49,791.	$12,696.	$70,007.

Table XXI - 175MM SP FIELD ARTILLERY BATTALION

VEHI-CLES	NUM-BER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M107	12	$5,862.	$1,716.	$6,283.	$1,236.	$8,830.
M548	12	1,704.	475.	1,823.	827.	2,582.
M577	5	896.	257.	958.	344.	1,347.
M88	1	863.	252.	929.	181.	1,305.
M578	1	848.	248.	912.	178.	1,282.
TOTAL		$9,834.	$2,844.	$10,542.	$2,714.	$14,839.

Table XXII - 8 INCH SP FIELD ARTILLERY BATTALION

VEHI-CLES	NUM-BER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M110	12	$5,187.	$1,513.	$5,584.	$1,089.	$7,845.
M548	12	1,704.	475.	1,823.	827.	2,582.
M577	5	896.	257.	958.	344.	1,347.
M578	2	848.	248.	912.	178.	1,282.
M88	1	863.	252.	929.	181.	1,305.
TOTAL		$9,497.	$2,741.	$10,207.	$2,620.	$14,362.

Table XXIII - 155MM SP FIELD ARTILLERY BATTALION

VEHI-CLES	NUM-BER	MEAN	S.D.	MEDIAN	MIN.	MAX.
M109A1	18	$8,968.	$2,618.	$9,651.	$2,195.	$13,366.
M548	18	2,556.	712.	2,735.	1,241.	3,873.
M577	10	1,792.	515.	1,917.	689.	2,695.
M578	1	509.	149.	547.	124.	775.
TOTAL		$13,826.	$3,990.	$14,850.	$4,251.	$21,010.

APPENDIX D

HEAVY EQUIPMENT TRANSPORTER COSTS ($)

This appendix has three tables. The first contains the road distances from garrison locations to the training sites. The second contains the HET movement costs generated by multiplying road distances in miles by $2.08 per mile. The third contains S.P. movement costs calculated by multiplying road distances in miles by $.44 per mile.

Table XXIV - ROAD DISTANCES (MILES)

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	99.	172.	174.	161.	82.
BAD HERSFELD	172.	181.	201.	189.	56.
BAD KISSIGEN	180.	116.	135.	123.	26.
BAD KREUZNACH	37.	234.	236.	224.	133.
BAUMHOLDER	0.	271.	273.	261.	170.
BUEDINGEN	122.	179.	181.	169.	63.
BUTZBACH	111.	206.	207.	195.	91.
DARMSTADT	83.	160.	191.	178.	99.
FRANKFURT	89.	186.	188.	175.	81.
FRIEDBURG	105.	198.	200.	188.	84.
FULDA	154.	150.	170.	158.	25.
GELENHAUSEN	117.	170.	171.	159.	53.
GIESSEN	122.	211.	215.	202.	85.
GRAFENWOEHR	271.	0.	60.	17.	134.
HANAU	102.	178.	180.	168.	68.
HOHENFELS	273.	60.	0.	35.	153.
IDAR OBERSTEIN	9.	267.	269.	256.	166.
MAINZ	66.	206.	208.	196.	104.
MANNHEIM	73.	196.	206.	194.	132.
VILSECK	261.	17.	35.	0.	141.
WIESBADEN	70.	205.	207.	196.	103.
WILDFLECKEN	170.	134.	153.	141.	0.

Table XXV - HET MOVEMENT COSTS ($)

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	206.	358.	362.	335.	171.
BAD HERSFELD	358.	376.	418.	393.	116.
BAD KISSIGEN	374.	241.	281.	256.	54.
BAD KREUZNACH	77.	487.	491.	466.	277.
BAUMHOLDER	0.	564.	568.	543.	354.
BUEDINGEN	254.	372.	376.	352.	131.
BUTZBACH	231.	428.	431.	406.	189.
DARMSTADT	173.	333.	379.	370.	206.
FRANKFURT	185.	387.	391.	364.	168.
FRIEDBURG	218.	412.	416.	391.	175.
FULDA	320.	312.	354.	329.	52.
GELENHAUSEN	243.	354.	357.	331.	110.
GIESSEN	254.	439.	447.	420.	177.
GRAFENWOEHR	564.	0.	125.	35.	279.
HANAU	212.	370.	374.	349.	141.
HOHENFELS	568.	125.	0.	73.	318.
IDAR OBERSTEIN	19.	555.	560.	532.	345.
MAINZ	137.	428.	433.	408.	216.
MANNHEIM	152.	408.	428.	403.	275.
VILSECK	543.	35.	73.	0.	293.
WIESBADEN	146.	426.	431.	408.	214.
WILDFLECKEN	354.	279.	318.	293.	0.

Table XXVI - S&P MOVEMENT COSTS ($)

	BAUMHOLDER	GRAFENWOEHR	HOHENFELS	VILSECK	WILDFLECKEN
BABENHAUSEN	44.	76.	77.	71.	36.
BAD HERSFELD	76.	80.	88.	83.	25.
BAD KISSIGEN	79.	51.	59.	54.	11.
BAD KREUZNACH	16.	103.	104.	99.	59.
BAUMHOLDER	0.	119.	120.	115.	75.
BUEDINGEN	54.	79.	80.	74.	28.
BUTZBACH	49.	91.	91.	86.	40.
DARMSTADT	37.	70.	84.	78.	44.
FRANKFURT	39.	82.	83.	77.	36.
FRIEDBURG	46.	87.	88.	83.	37.
FULDA	68.	66.	75.	70.	11.
GELENHAUSEN	51.	75.	75.	70.	23.
GIESSEN	54.	93.	95.	89.	37.
GRAFENWOEHR	119.	0.	26.	7.	59.
HANAU	45.	78.	79.	74.	30.
HOHENFELS	120.	26.	0.	15.	67.
IDAR OBERSTEIN	4.	117.	118.	113.	73.
MAINZ	29.	91.	92.	86.	46.
MANNHEIM	32.	86.	91.	85.	58.
VILSECK	115.	7.	15.	0.	62.
WIESBADEN	31.	90.	91.	86.	45.
WILDFLECKEN	75.	59.	67.	62.	0.

APPENDIX E

HEAVY EQUIPMENT TRANSPORTER COMAPNY COSTS ($)[2]

TOTAL PRESENT VALUE RECURRING COST (HET)	=	$18,423,000.
INVESTMENT COST (HET)	=	$7,000,000.
PRESENT VALUE OF TOTAL COST (HET)	=	$25,423,000.
RECURRING COST (HET) PER YEAR	=	$3,000,000.
RAIL COST ELIMINATED PER YEAR	=	$1,556,000.

PERCENT TOTAL HET COST OFFSET BY RAIL COST ELIMINATION $= \frac{\$9,555,396.}{\$25,423,000.} \times 100 = 37.5\%$

Table XXVII - HET COMPANY COST ($)

YEAR	PRESENT VALUE HET RECURRING COST ($)	PRESENT VALUE RAIL COST ($)
1	2,727,000.	1,414,404.
2	2,478,000.	1,285,256.
3	2,253,000.	1,168,556
4	2,049,000.	1,062,748.
5	1,860,000.	964,720.
6	1,692,000.	877,584.
7	1,539,000.	798,228.
8	1,398,000.	725,096.
9	1,272,000.	659,744.
10	1,155,000.	599,060.
TOTAL	18,423,000.	9,555,396.

----

[2]The HET and rail costs are based on the movement of 50 tanks per week for 40 weeks. A 10 percent discount rate was assumed.

APPENDIX F

SUMMARY DATA FOR TEST SCHEDULE

Table XXVIII

	LEVEL I	LEVEL II
RAIL COSTS ELIMINATED BY HETs	$1,500,437.	2,442,605.
HET OPERATING COSTS	598,491.	1,015,562.
NET SAVINGS	$ 901,946.	1,427,043.
RAIL COSTS ELIMINATED BY S&Ps	$ 231,786.	231,786.
S&P OPERATING COSTS	96,673.	96,673.
NET SAVINGS	$ 135,113.	135,113.
RAIL COSTS ELIMINATED BY ROAD MARCHES	$ 288,739.	288,739.
TOTAL GROSS SAVINGS	$2,020,962.	2,963,130.
TOTAL NET SAVINGS	$1,325,798.	1,850,895.
NUMBER OF BATTALIONS MOVED BY HETs	27.	41.
NUMBER OF BATTALIONS MOVED BY S&Ps	14.	14.
NUMBER OF VEHICLES MOVED BY HETs	1,629.	2,583.
NUMBER OF VEHICLES MOVED BY S&Ps	1,238.	1,238.
TOTAL RAIL COST WITHOUT SUBSTITUTION	$5,430,000.	5,430,000.

Table XXVIII (Continued)

	LEVEL I	LEVEL II
PERCENT TOTAL NET SAVINGS HETs	16.6	26.3
PERCENT TOTAL NET SAVINGS S&Ps	2.5	2.5
PERCENT TOTAL NET SAVINGS ROAD MARCHES	5.3	5.3
PERCENT TOTAL NET SAVINGS	24.4	35.9

APPENDIX G

DATA FROM RMER/UNIT TRAINING SCHEDULES

This appendix contains the data collected from the RMER report and unit training schedules. There are eight tables with one table for each artillery battalion in the 41st and 42nd Artillery Groups. Each table contains the RMER data and training schedule for the respective battalion.

2/75 FIELD ARTILLERY BATTALION (8 INCH SP)
41ST ARTILLERY GROUP

Table XXIX

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	6,953.	8,112.
21 Jul 76--25 Aug 76	14,362.	13,740.
25 Aug 76--21 Sep 76	26,313.	29,165.
21 Sep 76--23 Oct 76	22,326.	92,253.
23 Oct 76--29 Nov 76	11,960.	129,627.
29 Nov 76--23 Dec 76	22,981.	16,959.
23 Dec 76--24 Jan 77	6,266.	102,049.
24 Jan 77--28 Feb 77	25,761.	49,233.
28 Feb 77--21 Mar 77	8,268.	54,569.
21 Mar 77--21 Apr 77	10,461.	18,035.
21 Apr 77--11 May 77	16,776.	18,871.

DATES	TRAINING ACTIVITY
2 Jun 76-- 4 Jun 76	FTX
7 Jul 76-- 6 Aug 76	MTA GRAF
2 Sep 76--11 Sep 76	REFORGER
13 Sep 76--24 Sep 76	MAIT
1 Nov 76--15 Nov 76	AGI
7 Nov 76--23 Nov 76	MTA (WILDF)
13 Dec 76--17 Dec 76	V CORPS TAV
17 Jan 77--19 Jan 77	NSI
18 Feb 77--21 Mar 77	MTA (GRAF)
29 Apr 77-- 6 May 77	FTX

2/5 FIELD ARTILLERY BATTALION (175 MM SP)
41ST ARTILLERY GROUP

Table XXX

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	175.	3,090.
21 Jul 76--25 Aug 76	19,583.	19,583.
25 Aug 76--21 Sep 76	17,300.	22,249.
21 Sep 76--23 Oct 76	13,429.	62,606.
23 Oct 76--29 Nov 76	14,942.	91,924.
29 Nov 76--23 Dec 76	11,734.	19,044.
23 Dec 76--24 Jan 77	6,758.	117,684.
24 Jan 77--28 Feb 77	15,747.	44,205.
28 Feb 77--21 Mar 77	13,569.	46,439.
21 Mar 77--21Apr 77	9,512.	14,719.
21 Apr 77--11 May 77	6,299.	10,408.

DATES	TRAINING ACTIVITY
1 Jul 76--29 Jul 76	MTA GRAF
2 Sep 76--11 Sep 76	REFORGER
8 Dec 76--17 Dec 76	MAIT
31 Jan 77--25 Feb 77	MTA GRAF
28 Mar 77-- 9 Apr 77	AGI
29 Apr 77-- 6 May 77	FTX

1/32 FIELD ARTILLERY BATTALION (LANCE)
41ST ARTILLERY GROUP

Table XXXI

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	12,005.	13,305.
21 Jul 76--25 Aug 76	21,966.	20,144.
25 Aug 76--21 Sep 76	18,634.	21,294.
21 Sep 76--23 Oct 76	15,836.	61,670.
23 Oct 76--29 Nov 76	8,536.	82,958.
29 Nov 76--23 Dec 76	11,389.	15,917.
23 Dec 76--24 Jan 77	10,481.	78,029.
24 Jan 77--28 Feb 77	29,323.	47,529.
28 Feb 77--21 Mar 77	13,707.	62,013.
21 Mar 77--21 Apr 77	17,743.	17,918.
21 Apr 77--11 May 77	2,803.	25,309.

DATES	TRAINING ACTIVITY
2 Jun 76-- 4 Jun 76	FTX
15 Jun 76--17 Jun 76	BN ARTEP
9 Aug 76--13 Aug 76	V CORPS TAV
25 Aug 76--27 Aug 76	NSI
2 Sep 76--11 Sep 76	REFORGER
5 Oct 76-- 7 Oct 76	FTX
16 Nov 76--18 Nov 76	FTX
28 Feb 77-- 4 Mar 77	V CORPS NSE
29 Apr 77-- 6 May 77	FTX
6 Jun 77--10 Jun 77	AGI

2/83 FIELD ARTILLERY BATTALION (8 INCH SP)
41ST ARTILLERY GROUP

Table XXXII

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	1,181.	988.
21 Jul 76--25 Aug 76	19,452.	19,452.
25 Aug 76--21 Sep 76	19,673.	20,830.
21 Sep 76--23 Oct 76	18,914.	89,357.
23 Oct 76--29 Nov 76	33,438.	153,482.
29 Nov 76--23 Dec 76	32,660.	39,251.
23 Dec 76--24 Jan 77	8,150.	150,033.
24 Jan 77--28 Feb 77	22,223.	54,618.
28 Feb 77--21 Mar 77	14,750.	36,706.
21 Mar 77--21 Apr 77	11,164.	11,299.
21 Apr 77--11 May 77	7,913.	10,254.

DATES	TRAINING ACTIVITY
21 Jun 76--23 Jun 76	FTX
9 Jul 76--26 Jul 76	MTA GRAF
2 Sep 76--11 Sep 76	REFORGER
29 Nov 76-- 3 Dec 76	AGI
10 Jan 77--10 Feb 77	MTA GRAF
7 Mar 77--11 Mar 77	V CORPS NSAU
28 Mar 77-- 1 Apr 77	NSI
29 Apr 77-- 6 May 77	FTX
21 Jun 77--22 Jul 77	MTA GRAF

6/9 FIELD ARTILLERY BATTALION (175 MM SP)
42ND ARTILLERY GROUP

Table XXXIII

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	2,253.	2,948.
21 Jul 76--25 Aug 76	18,674.	19,109.
25 Aug 76--21 Sep 76	39,488.	42,845.
21 Sep 76--23 Oct 76	40,638.	99,003.
23 Oct 76--29 Nov 76	24,725.	73,920.
29 Nov 76--23 Dec 76	27,526.	12,414.
23 Dec 76--24 Jan 77	24,261.	74,542.
24 Jan 77--28 Feb 77	23,958.	43,877.
28 Feb 77--21 Mar 77	6,426.	39,852.
21 Mar 77--21 Apr 77	26,079.	9,441.
21 Apr 77--11 May 77	11,635.	11,946.

DATES	TRAINING ACTIVITY
21 Jun 76--25 Jun 76	AGI
1 Jul 76--31 Jul 76	MTA GRAF
28 Jul 76--31 Jul 76	RN ARTEP (GRAF)
4 Sep 76--11 Sep 76	REFORGER (MAN)
4 Oct 76-- 8 Oct 76	FTX
8 Nov 76--12 Nov 76	FTX
6 Dec 76-- 9 Dec 76	CPX
10 Mar 77--15 Mar 77	CPX
2 May 77-- 7 May 77	FTX (CORPS)
23 May 77--26 May 77	MTX (Finthen)

3/79 FIELD ARTILLERY BATTALION (LANCE)
42ND ARTILLERY GROUP

Table XXXIV

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	6,710.	6,301.
21 Jul 76--25 Aug 76	5,126.	5,126.
25 Aug 76--21 Sep 76	25,714.	27,687.
21 Sep 76--23 Oct 76	16,431.	51,613.
23 Oct 76--29 Nov 76	12,149.	76,867.
29 Nov 76--23 Dec 76	24,278.	3,240.
23 Dec 76--24 Jan 77	15,300.	51,970.
24 Jan 77--28 Feb 77	15,796.	40,284.
28 Feb 77--21 Mar 77	10,775.	55,433.
21 Mar 77--21 Apr 77	22,060.	10,631.
21 Apr 77--11 May 77	11,039.	11,046.

DATES	TRAINING ACTIVITY
1 Jun 76-- 3 Jun 76	FTX
14 Jun 76--18 Jun 76	BN ARTEP
23 Aug 76--27 Aug 76	AGI
4 Sep 76-- 1 Sep 76	REFORGER (MAN)
27 Sep 76--29 Sep 76	FTX
19 Oct 76--22 Oct 76	BN ARTEP
7 Nov 76--27 Nov 76	ASP (CRETE)
2 Dec 76-- 3 Dec 76	NSE
6 Dec 76-- 9 Dec 76	CPX
15 Mar 77--15 Mar 77	CPX

Table XXXIV (Continued)

DATES	TRAINING ACTIVITY
14 Mar 77--18 Mar 77	NSAV
4 Apr 77-- 8 Apr 77	NSI
2 May 77-- 7 May 77	FTX (CORPS)
15 May 77-- 5 Jun 77	ASP (CRETE)

2/92 FIELD ARTILLERY BATTALION (8 INCH SP)
42ND ARTILLERY GROUP

Table XXXV

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	261.	577.
21 Jul 76--25 Aug 76	19,347.	18,996.
25 Aug 76--21 Sep 76	17,808.	22,669.
21 Sep 76--23 Oct 76	14,811.	64,166.
23 Oct 76--29 Nov 76	21,097.	64,066.
29 Nov 76--23 Dec 76	20,086.	23,833.
23 Dec 76--24 Jan 77	18,622.	76,297.
24 Jan 77--28 Feb 77	29,162.	67,855.
28 Feb 77--21 Mar 77	7,379.	73,522.
21 Mar 77--21 Apr 77	29,141.	20,811.
21 Apr 77--11 May 77	5,864.	6,504.

DATES	TRAINING ACTIVITY
21 Jun 76--30 Jun 76	BN ARTEP
24 May 76-- 8 Oct 76	REFORGER (JVB)
26 Oct 76--29 Oct 76	NSAV
29 Nov 76-- 1 Dec 76	NSE
6 Dec 76-- 9 Dec 76	CPX
24 Jan 77--28 Jan 77	TAV
2 Feb 77-- 3 Mar 77	MTA (GRAF)
10 Mar 77--15 Mar 77	CPX
14 Mar 77--18 Mar 77	AGI
5 Apr 77--30 Apr 77	MTA GRAF
2 May 77-- 7 May 77	FTX CORPS

1/333 FIELD ARTILLERY BATTALION (LANCE)
42ND ARTILLERY GROUP

Table XXXVI

DATES	TOTAL EXPENSES ($) II, IV, IX	TOTAL DEMANDS ($) II, III, IV, IX
22 Jun 76--21 Jul 76	4,105.	4,324.
21 Jul 76--25 Aug 76	--	--
25 Aug 76--21 Sep 76	15,824.	15,824.
21 Sep 76--23 Oct 76	5,169.	33,718.
23 Oct 76--29 Nov 76	7,872.	62,085.
29 Nov 76--23 Dec 76	11,115.	13,908.
23 Dec 76--24 Jan 77	9,451.	89,725.
24 Jan 77--28 Feb 77	24,448.	50,406.
28 Feb 77--21 Mar 77	25,656.	59,622.
21 Mar 77--21 Apr 77	11,142.	24,730.
21 Apr 77--11 May 77	14,219.	18,725.

DATES	TRAINING ACTIVITY
7 Jun 76--11 Jun 76	AGI
17 Jun 76-- 1 Jul 76	ADVENTURE TRN
23 Aug 76--27 Aug 76	TEI
4 Sep 76--11 Sep 76	REFORGER (MAN)
19 Sep 76-- 9 Oct 76	ASP (CRETE)
12 Oct 76--15 Oct 76	TAV
3 Nov 76-- 5 Nov 76	TPI
6 Dec 76-- 9 Dec 76	CPX
13 Dec 76--15 Dec 76	BN ARTEP
10 Mar 77--15 Mar 77	CPX
21 Mar 77--25 Mar 77	TEI

Table XXXVI (Continued)

DATES	TRAINING ACTIVITY
18 Apr 77--22 Apr 77	NSI
2 May 77-- 7 May 77	FTX (CORPS)

APPENDIX H

REPAIR PART DEMANDS AND TANK FLEET AGE

This appendix contains eleven tables which represent the repair-part demands and tank fleet age of the six armor battalions in the 3rd Armored Division and the five armor battalions in the 8th MI Division. Each table lists the mean and standard deviation for the battalion and the corresponding Corps mean and standard deviation for each repair-part and tank fleet age. Column 1 and 2 of repair-part demands represent the first and second six month demands respectively. The total column is the sum of columns one and two for a one year total.

Table XXXVII - REPAIR-PART DEMANDS/FLEET AGE

1/32 ARMOR BATTALION 3RD ARMOR DIVISION

	1/32		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	73.32	1.34	72.47	2.38

	REPAIR-PART DEMANDS				
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	72	93	165	153.	55.2
Sprocket, final drive(0229)	5	6	11	3.09	4.7
Link assembly	2	6	8	2.27	2.37
Wheel, road (9292)	42	23	65	67.	36.1
Pump, fuel (0165)	6	9	15	4.9	4.41
Cylinder assembly	2	0	2	2.63	3.38
Sprocket, final drive(5637)	0	4	4	21.6	19.2
Spring, valute	0	0	0	3.54	5.26
Pump, fuel (4248)	9	3	12	6.09	4.98
Shock absorber	2	1	3	17.9	13.2

Table XXXVIII - REPAIR-PART DEMANDS/FLEET AGE

2/32 ARMOR BATTALION 3RD ARMOR DIVISION

	2/32		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	72.9	1.43	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	76	62	138	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	0	0	0	2.27	2.37
Wheel, road (9292)	14	39	53	67.	36.1
Pump, fuel (0165)	2	0	2	4.9	4.41
Cylinder assembly	1	10	11	2.63	3.38
Sprocket, final drive(5637)	7	41	48	21.6	19.2
Spring, valute	7	0	7	3.54	5.26
Pump, fuel (4248)	0	5	5	6.09	4.98
Shock absorber	20	17	37	17.9	13.2

Table XXXIX - REPAIR-PART DEMANDS/FLEET AGE

3/32 ARMOR BATTALION 3RD ARMOR DIVISION

	3/32		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	73.4	.92	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	105	103	208	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	1	2	3	2.27	2.37
Wheel, road (9292)	23	17	40	67.	36.1
Pump, fuel (0165)	0	3	3	4.9	4.41
Cylinder assembly	2	2	4	2.63	3.38
Sprocket, final drive(5637)	1	3	4	21.6	19.2
Spring, valute	0	2	2	3.54	5.26
Pump, fuel (4248)	1	0	1	6.09	4.98
Shock absorber	4	20	24	17.9	13.2

Table XL - REPAIR-PART DEMANDS/FLEET AGE

1/33 ARMOR BATTALION 3RD ARMOR DIVISION

	1/33		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	75.0	1.52	72.47	2.38

	REPAIR-PART DEMANDS				
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	17	52	69	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	0	1	1	2.27	2.37
Wheel, road (9292)	35	25	60	67.	36.1
Pump, fuel (0165)	2	5	7	4.9	4.41
Cylinder assembly	0	0	0	2.63	3.38
Sprocket, final drive(5637)	0	42	42	21.6	19.2
Spring, valute	0	2	2	3.54	5.26
Pump, fuel (4248)	0	6	6	6.09	4.98
Shock absorber	0	18	18	17.9	13.2

Table XLI - REPAIR-PART DEMANDS/FLEET AGE

2/33 ARMOR BATTALION 3RD ARMOR DIVISION

	2/33		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	73.4	.80	72.47	2.38

	REPAIR-PART DEMANDS				
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	37	39	76	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	0	0	0	2.27	2.37
Wheel, road (9292)	33	37	70	67.	36.1
Pump, fuel (0165)	0	1	1	4.9	4.41
Cylinder assembly	0	0	0	2.63	3.38
Sprocket, final drive(5637)	0	22	22	21.6	19.2
Spring, valute	0	0	0	3.54	5.26
Pump, fuel (4248)	0	2	2	6.09	4.98
Shock absorber	3	0	3	17.9	13.2

Table XLII - REPAIR-PART DEMANDS/FLEET AGE

3/33 ARMOR BATTALION 3RD ARMOR DIVISION

	3/33		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	73.5	.66	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	89	52	141	153.	55.2
Sprocket, final drive(0229)	0	4	4	3.09	4.7
Link assembly	1	2	3	2.27	2.37
Wheel, road (9292)	3	10	13	67.	36.1
Pump, fuel (0165)	1	4	5	4.9	4.41
Cylinder assembly	0	0	0	2.63	3.38
Sprocket, final drive(5637)	0	4	4	21.6	19.2
Spring, valute	0	0	0	3.54	5.26
Pump, fuel (4248)	2	1	3	6.09	4.98
Shock absorber	2	2	4	17.9	13.2

Table XLIII - REPAIR-PART DEMANDS/FLEET AGE

1/68 ARMOR BATTALION 8TH MI DIVISION

	1/68		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	71.31	3.06	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	94	31	125	153.	55.2
Sprocket, final drive(0229)	0	2	2	3.09	4.7
Link assembly	0	0	0	2.27	2.37
Wheel, road (9292)	41	43	84	67.	36.1
Pump, fuel (0165)	6	0	6	4.9	4.41
Cylinder assembly	2	0	2	2.63	3.38
Sprocket, final drive(5637)	2	4	6	21.6	19.2
Spring, valute	14	3	17	3.54	5.26
Pump, fuel (4248)	11	3	14	6.09	4.98
Shock absorber	1	5	6	17.9	13.2

Table XLIV - REPAIR-PART DEMANDS/FLEET AGE

2/68 ARMOR BATTALION 8TH MI DIVISION

	2/68		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	71.89	2.55	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	104	110	214	153.	55.2
Sprocket, final drive(0229)	0	13	13	3.09	4.7
Link assembly	2	2	4	2.27	2.37
Wheel, road (9292)	5	59	64	67.	36.1
Pump, fuel (0165)	5	5	10	4.9	4.41
Cylinder assembly	0	0	0	2.63	3.38
Sprocket, final drive(5637)	0	31	31	21.6	19.2
Spring, valute	1	1	2	3.54	5.26
Pump, fuel (4248)	7	17	24	6.09	4.98
Shock absorber	0	3	3	17.9	13.2

Table XLV - REPAIR-PART DEMANDS/FLEET AGE

3/68 ARMOR BATTALION 8TH MI DIVISION

	3/68		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	71.05	2.73	72.47	2.38

			REPAIR-PART DEMANDS		
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	139	85	224	153.	55.2
Sprocket, final drive(0229)	0	4	4	3.09	4.7
Link assembly	2	1	3	2.27	2.37
Wheel, road (9292)	43	22	65	67.	36.1
Pump, fuel (0165)	3	0	3	4.9	4.41
Cylinder assembly	2	4	6	2.63	3.38
Sprocket, final drive(5637)	32	23	55	21.6	19.2
Spring, valute	6	2	8	3.54	5.26
Pump, fuel (4248)	9	5	14	6.09	4.98
Shock absorber	5	11	16	17.9	13.2

Table XLVI - REPAIR-PART DEMANDS/FLEET AGE

5/68 ARMOR BATTALION 8TH MI DIVISION

	5/68		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	70.98	3.11	72.47	2.38

			REPAIR-PART DEMANDS		
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	56	59	115	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	0	2	2	2.27	2.37
Wheel, road (9292)	15	48	63	67.	36.1
Pump, fuel (0165)	1	0	1	4.9	4.41
Cylinder assembly	1	0	1	2.63	3.38
Sprocket, final drive(5637)	2	8	10	21.6	19.2
Spring, valute	0	1	1	3.54	5.26
Pump, fuel (4248)	3	3	6	6.09	4.98
Shock absorber	9	12	21	17.9	13.2

Table XLVII - REPAIR-PART DEMANDS/FLEET AGE

4/69 ARMOR BATTALION 8TH MI DIVISION

	4/69		V CORPS	
	MEAN	S.D.	MEAN	S.D.
MANUFACTURE/REBUILD DATE	70.81	1.66	72.47	2.38

				REPAIR-PART DEMANDS	
REPAIR-PART NOMENCLATURE	1	2	TOTAL	MEAN	S.D.
Battery, storage	125	83	208	153.	55.2
Sprocket, final drive(0229)	0	0	0	3.09	4.7
Link assembly	1	0	1	2.27	2.37
Wheel, road (9292)	77	84	161	67.	36.1
Pump, fuel (0165)	1	0	1	4.9	4.41
Cylinder assembly	3	0	3	2.63	3.38
Sprocket, final drive(5637)	4	8	12	21.6	19.2
Spring, valute	0	0	0	3.54	5.26
Pump, fuel (4248)	0	1	1	6.09	4.98
Shock absorber	35	6	41	17.9	13.2

APPENDIX I

USER'S GUIDE FOR THE V CORPS MTA SCHEDULING PROGRAM

TABLE OF CONTENTS

I. INTRODUCTION....................127

II. INFORMATION CODES....................128

A. THE DESIGNATION OF THE REQUESTING UNIT......128

B. MAJOR HEADQUARTERS....................130

C. TYPE UNIT....................131

D. TYPE TRAINING....................133

E. PRIORITY....................133

F. PERIOD....................134

G. DENSITY....................135

H. DEPARTURE LOCATION AND MTA....................136

III. DECK SET UP FOR THE V CORPS MTA SCHEDULING PROGRAM....................138

A. COMPOSITION OF THE DATA DECK....................138

B. DECK SET UP FOR EXECUTION....................146

I. INTRODUCTION

The V Corps MTA Scheduling Program is a FORTRAN program designed to schedule V Corps elements intc the Baumhclder, Grafenwoehr, Hohenfels, and Wildflecken training areas based on training requests and constraints supplied by the user. This appendix supplements the system information provided in Section IV, SCHEDULING MTA OPERATIONS, and describes the actions required to prepare the program for execution. The procedures described in this section must be followed precisely to insure the proper functioning of the program.

II. INFORMATION CODES

As described in Section IV, there are nine items of information required to process a request for training. This section reviews these elements of information and provides the codes which must be used when placing this information onto the data input cards.

A. THE DESIGNATION OF THE REQUESTING UNIT

The first entry on each request is the designation of the unit requesting training. The program has the capability to process thirty different unit designations for each major headquarters. Thus, if requests are processed by brigade, battalion , and independent company, every element of a division can be processed at one time. For special events, such as combined arms training or multinational training, where elements from more than one battalion are participants, it is recommended that the brigade designation or the designation of the battalion with operational control of the exercise be used.

The code for the unit designation must consist of at least one and no more than four alphanumeric characters. These characters may be any combination of the following symbols: letters, digits, punctuation, or the character blank. The code for any unit is arbitrary provided that it satisfies the above coding instructions. The only other restriction is that each unit with the same major headquarters must be given a unique code. Examples of

proper and improper codes are shown in Table XLVIII.

Table XLVIII - EXAMPLES OF VALID AND INVALID UNIT DESIGNATION CODES

	UNIT	POSSIBLE ALPHA-NUMERIC CODE	COMMENT
1.	3-68/8th ID	3-68	Valid
2.	503 MI CO/3rd AD	503 or, 3ΔMI	Valid; Δ indicates blank
3.	503 MI CO/3rd AD	503ΔMI	Invalid, code exceed the allowable name length
4.	3-16/8th ID	3-16	Valid
5.	58 EN CO/11th ACR	58 or, 58 EN	Valid
6.	503 MI CO/3rd AD 503 MP CO/3rd AD	503m 503m	Invalid since every unit of each major head-quarters must be given a unique code
7.	503 MI CO/3rd AD 503 MP CO/3rd AD	3ΔMI 3ΔMP	Valid

B. MAJOR HEADQUARTERS

The second entry on a request data card is a code number indicating the major headquarters of the requesting unit. These codes are used to logically store and seperate the scheduled training. Valid coding information is given in Table XLIX.

Table XLIX - CODE NUMBERS FOR V CORPS MAJOR HEADQUARTERS

MAJOR HEADQUARTERS	CODE NUMBER
3rd Armor Division	1
8th Mech Infantry Division	2
11th Armored Cavalry Regiment	3
41st Artillery Group	4
42nd Artillery Group	5
130th Engineer Brigade	6
Brigade 76	7
3rd Support Command	8
Other	9

C. TYPE UNIT

The third entry on the request is a code number indicating the "type" of the unit. This provides the program with information concerning the equipment which must be transported to the MTA. A series of cost matrices are stored within the program with one matrix available for each "type" of unit discussed here. Thus, given the type of unit requesting training and given its departure location, the program can assign a rail movement cost to each request. The cost is based on 100% of the assigned tracked vehicles moving by rail. As mentioned in Section IV, these costs are used only to break ties when units with equal priority are competing for the final density on a full schedule. These cost figures, which are recorded in German Marks, were computed in accordance with the procedures outlined in Appendix A. They are used to determine which unit in a given pair will have the highest movement cost if sent to a MTA by rail. Therefore, inflation or proportional changes in rates will not affect the validity of the decision process. Only a complete reversal of existing rate schemes can cause this process to become inaccurate. The only exceptions to this cost comparison occur when infantry and engineer units request weapons firing training, or when engineer and support units request support densities. In these instances distance figures are substituted for costs because of the variability of the kind of equipment required to accomplish the training. The logic of the comparison remains the same so that the shorter movement distance is preferable. the "type" unit codes are given in Table L. note that there is a zero cost associated with the category "Other", which is code number 12.

Table L - TYPE UNIT CODE NUMBERS

TYPE UNIT	CODE NUMBERS
M60A1-Armor	1
M60A2-Armor	2
Armored Cavalry	3
Mechanized Infantry	4
Engineer	5
155MM Artillery	6
175MM Artillery	7
8 IN Artillery	8
Support	9
Combined Arms-Tank Heavy	10
Combined Arms-Infantry Heavy	11
Other	12

D. TYPE TRAINING

The fourth entry on the data card indicates the type training requested. Type training refers to one of the six training categories discussed in Section IV. These categories and their code numbers are shown in Table LI.

Table LI - TRAINING CATEGORY CODE NUMBERS

TRAINING CATEGORY	CODE NUMBER
Tank Gunnery, Level I	1
Tank Gunnery, Level II	2
Weapons Firing	3
Artillery Firing	4
Maneuver	5
Support	6

E. PRIORITY

The fifth entry on a data card indicates the priority assigned to that request. Priorities influence assignments by type training and should be assigned accordingly. For example, requests for weapons firing do not compete for densities with requests for maneuver training. The facilities and/or time required for different types of training are not compatable. Thus, priorities should be assigned by considering only those requests for the same type of training. Priorities must be indicated by assigning

D. TYPE TRAINING

The fourth entry on the data card indicates the type training requested. Type training refers to one of the six training categories discussed in Section IV. These categories and their code numbers are shown in Table LI.

Table LI - TRAINING CATEGORY CODE NUMBERS

TRAINING CATEGORY	CODE NUMBER
Tank Gunnery, Level I	1
Tank Gunnery, Level II	2
Weapons Firing	3
Artillery Firing	4
Maneuver	5
Support	6

E. PRIORITY

The fifth entry on a data card indicates the priority assigned to that request. Priorities influence assignments by type training and should be assigned accordingly. For example, requests for weapons firing do not compete for densities with requests for maneuver training. The facilities and/or time required for different types of training are not compatable. Thus, priorities should be assigned by considering only those requests for the same type of training. Priorities must be indicated by assigning

any number between one and 99, where one indicates the highest pricrity possible, and 99 indicates the lowest priority which may be assigned. There is no requirement to assign each request a different priority. This is a feature which allows the user to idetify and protect critical training exercises.

F. PERIOD

The sixth entry on a request specifies the training period desired. As discussed in section IV, the V Corps training section will provide each major headquarters with a breakdown by type training of the number of training periods available and the inclusive dates of each period. The period code is the numerical designation assigned each period by V Corps. Program dimensions require that the number of periods for each type of training be less than or equal to the limits shown in Table LII.

Table LII - PROGRAM CONSTRAINTS ON THE MAXIMUM NUMBER OF PERIODS AUTHORIZED FOR EACH TRAINING CATEGORY

TRAINING CATEGORY	MAXIMUM NUMBER OF PERIODS
Tank Gunnery, Level I	20
Tank Gunnery, Level II	20
Weapons Firing	20
Artillery Firing	20
Maneuver	30
Support	20

G. DENSITY

The seventh entry on a request specifies the density required by the training element. This value must always be an integer greater than or equal to one. A density value of "one" traditionally represents one battalion size force; however, smaller or larger elements may be scheduled by adjusting the scale. Thus, the smallest element needed to be scheduled should represent a density of one. As an example, if company-size elements were the smallest units to be scheduled, then a battalion with three organic companies would request a density of three. Program dimensions limit the feasible density for any one period and type training. These limits are shown in Table LIII.

Table LIII - PROGRAM DENSITY CONSTRAINTS BY TRAINING CATEGORY

TRAINING CATEGORY	MAXIMUM DENSITY PER PERIOD
Tank Gunnery, Level I	10
Tank Gunnery, Level II	10
Weapons Firing	10
Artillery Firing	10
Maneuver	15
Support	10

H. DEPARTURE LOCATION AND MTA

The eighth and ninth entries on a request indicate the garrison location of the requesting unit and the training area desired respectively. Table LIV gives the name and code number of all feasible departure locations and training areas. If the garrison location of any requesting unit is not included in this list, then the nearest location found in Table LIV should be used.

Table LIV - LOCATION CODE NUMBERS

LOCATION	CODE NUMBER
BAUMHOLDER	1
GRAFENWOEHR	2
HOHENFELS	3
WILDFLECKEN	4
BABENHAUSEN	5
BAD HERSFELD	6
BAD KISSIGEN	7
BAD KREUZNACH	8
BUEDINGEN	9
BUTZBACH	10
DARMSTADT	11
FRANKFURT	12
FRIEDBURG	13
FULDA	14
GELENHAUSEN	15
GIESSEN	16
HANAU	17
IDAR OBERSTEIN	18
MAINZ	19
MANNHEIM	20
VILSEK	21
WIESBADEN	22

III. DECK SET UP FOR THE V CORPS MTA SCHEDULING PROGRAM

A. COMPOSITION OF THE DATA DECK

The source program expects to receive specific pieces of information according to an established sequence. Therefore, the scheduler must prepare and order the data deck in accordance with established instructions. This section describes the format and purpose of each data card and the order in which it must appear in the data deck.

1. the first card in the data deck is the output control card. The scheduler uses this card to specify the format of the schedule printout. As described in Section IV there are three output options. To receive any one, or any group of these options, prepare one card using the following procedures:

a. If Option One is desired, punch the numeral one in card column ten. If Option One is not desired, leave card column ten blank.

b. If Option Two is desired, punch the numeral two in card column twenty. If Option Two is not desired, leave card column twenty blank.

c. If Option Three is desired, punch the numeral three in card column thirty. If Option Three is not desired, leave card column thirty blank.

Figure 7 shows an example of a valid output control card. This card will cause the program to print Options One and Two and to suppress Option Three.

2. The second card in the data deck designates the number of periods assigned to each training category. The literal numerical value designating the number of periods assigned to each category must be punched in the appropriate card columns as they are described in Table LV. If any category receives no periods, leave its designated card columns blank.

Table IV - DATA CARD COLUMN ASSIGNMENTS FOR PERIOD ALLOCATIONS

TRAINING CATEGORY	CARD COLUMN FOR TWO DIGIT NUMBERS	CARD COLUMN FOR SINGLE DIGIT NUMBER
Tank Gunnery, Level I	9 - 10	10
Tank Gunnery, Level II	19 - 20	20
Weapons Firing	29 - 30	30
Artillery Firing	39 - 40	40
Maneuver Training	49 - 50	50
Support	59 - 60	60

```
                 1            2
CC               10           20           30



      THIS CARD WILL CAUSE THE PROGRAM TO PRINT OPTIONS
      ONE AND TWO, AND TO SUPRESS OPTION THREE.
```

Figure 7 - AN EXAMPLE OF A VALID OUTPUT CONTROL CARD

3. The next six groups of cards designate the densities authorized for each period of each training category. These groups must be arranged by training category in the following order:

a. tank gunnery, level one;

b. tank gunnery, level two;

c. weapons firing;

d. artillery firing;

e. maneuver training; and,

f. support.

Within each training category the densities must be ordered by period. For example, Table LVI describes a hypothetical situation where each training category has been assigned a specific number of periods and each period has been assigned an authorized density. For simplicity, each period of a type training category has been assigned the same authorized density. The density of each period of each training category must be punched onto a single data card in card columns nine and ten. Thus, the six groups of cards designating the densities requested in this example would have the follcwing format:

Group one: ten cards, each with a "1" punched in column nine and a "0" punched in column ten,

Group two: seven cards, each with a "2" punched in column ten,

Group three: eight cards, each with a "3" punched in column ten,

Group four: fifteen cards, each with a "6" punched in cclumn ten,

Group five: twenty cards, each with a "1" punched in column nine and a "2" punched in column ten, and

Group six:, twelve cards, each with a "3" punched in column ten.

If any training category receives no periods, then simply cmit the group of density cards for that category.

Table LVI - AN EXAMPLE OF PERIOD AND DENSITY ALLOCATIONS BY TRAINING CATEGORY

TYPE TRAINING	NUMBER OF PERIODS	DENSITY PER PERIOD
Tank Gunnery, Level I	10	10
Tank Gunnery, Level II	7	2
Weapons Firing	8	3
Artillery Firing	15	6
Maneuver Training	20	12
Support	12	3

4. The final group of data cards required are the requests for training. These cards may be placed in any convenient order, and the scheduling program will seperate and order the schedule information as necessary. The request data must be punched in the card columns assigned in Table LVII, and must conform to the information codes defined in Section II of this appendix. When entering the designation of the requesting unit always begin in card column one, use as many of the first four columns as necessary, and leave any unused columns blank. When entering the integer code values for other items of information, use the right most authorized column for entering single digit numbers. For example, for a request assigned a priority of two, the numeral two must be entered in card column 16.

Table LVII - DATA CARD COLUMN ASSIGNMENTS FOR INFORMATION REQUIRED ON EACH TRAINING REQUEST

INFORMATION ITEM	CARD COLUMN
Designation of Requesting Unit	1-4
Major Headquarters	7
Type Unit	9-10
Type Training	13
Priority	15-16
Period	18-19
Density	21-22
Departure Location	24-25
Major Training Area	28

5. The final card of the data section informs the program that all requests for training have been processed. This card must have the word "LAST" typed in card columns one through four, and it must be placed immediately after the last request for training. Figure 8 shows an example of this card prepared in the proper format.

```
   LAST
CC 123456789

THIS CARD INFORMS THE PROGRAM THAT ALL REQUESTS FOR
TRAINING HAVE BEEN PROCESSED, AND MUST HAVE THE WORD
"LAST" PUNCHED IN CARD COLUMNS ONE THROUGH FOUR.
```

Figure 8 - THE FINAL CARD OF THE DATA DECK

6. Figure 9 presents a schematic drawing which depicts the proper arrangement of all required cards in the data deck.

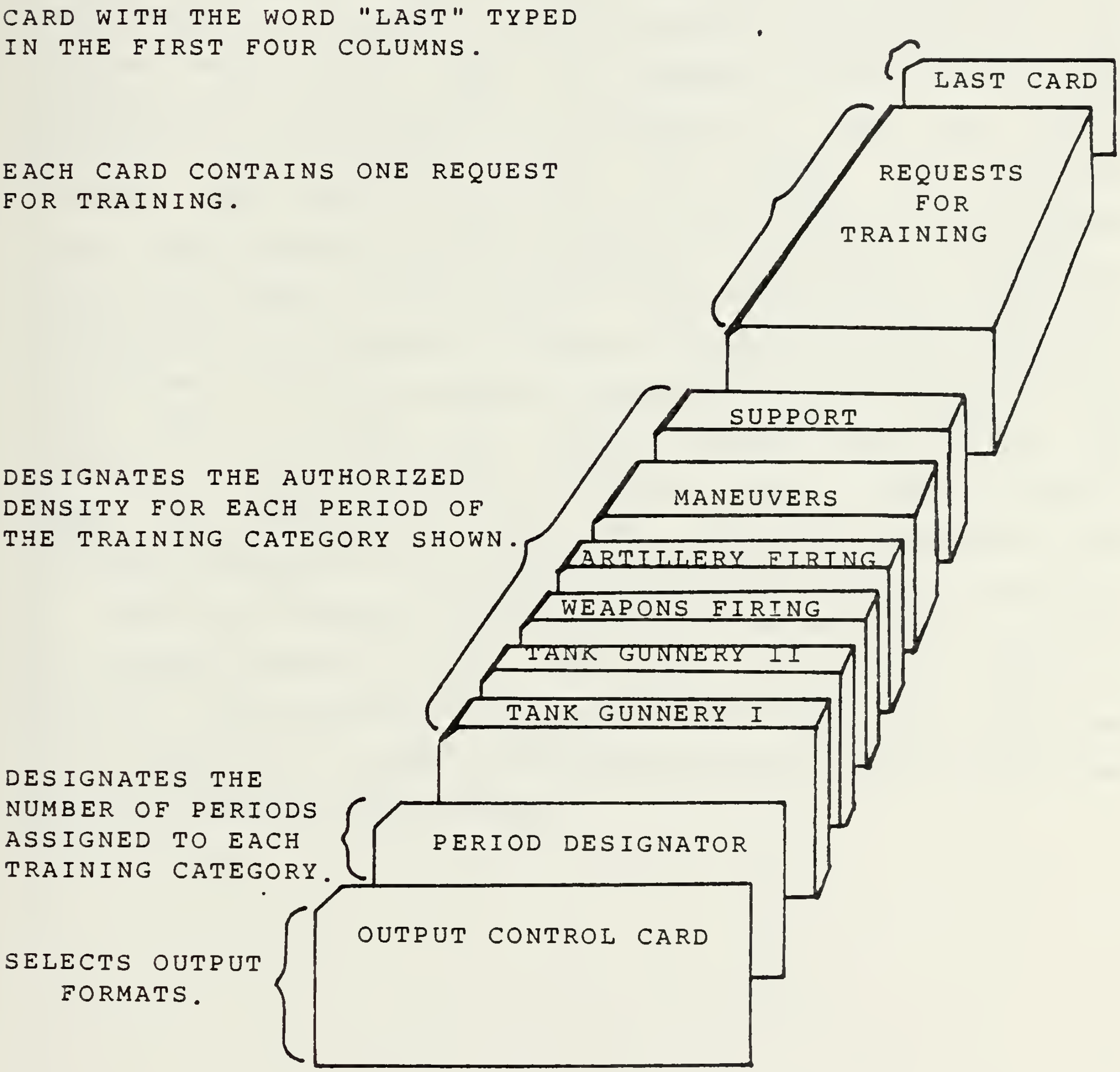

Figure 9 - THE PROPER ARRANGEMENT OF THE DATA DECK

B. DECK SET UP FOR EXECUTION

When the program is submitted for execution the deck must be arranged in a specific sequence. The first set of cards in the deck establish communication with the operating system. These are job control cards and the preparation of these cards is directed by the operating procedures of the system being used. Next in sequence is the source deck containing the instructions necessary to read the data, schedule the training, print the output, and stop the program. This deck is available in the form of a FORTRAN source deck containing cards punched in FORTRAN IV language, or in the form of an object deck containing the same information but punched in machine language. Local operating procedures will dictate which source deck must be used. The third set of cards are control cards which prepare the system to accept externally submitted data. These control cards are followed by the data deck which provides the schedule constraints and requests. The final set of cards in the deck are control cards which inform the system that it has reached the end of the data set. Figure 10 shows a typical deck properly arranged for execution. Note that the exact form of all control cards must be coordinated with the operators of the using system.

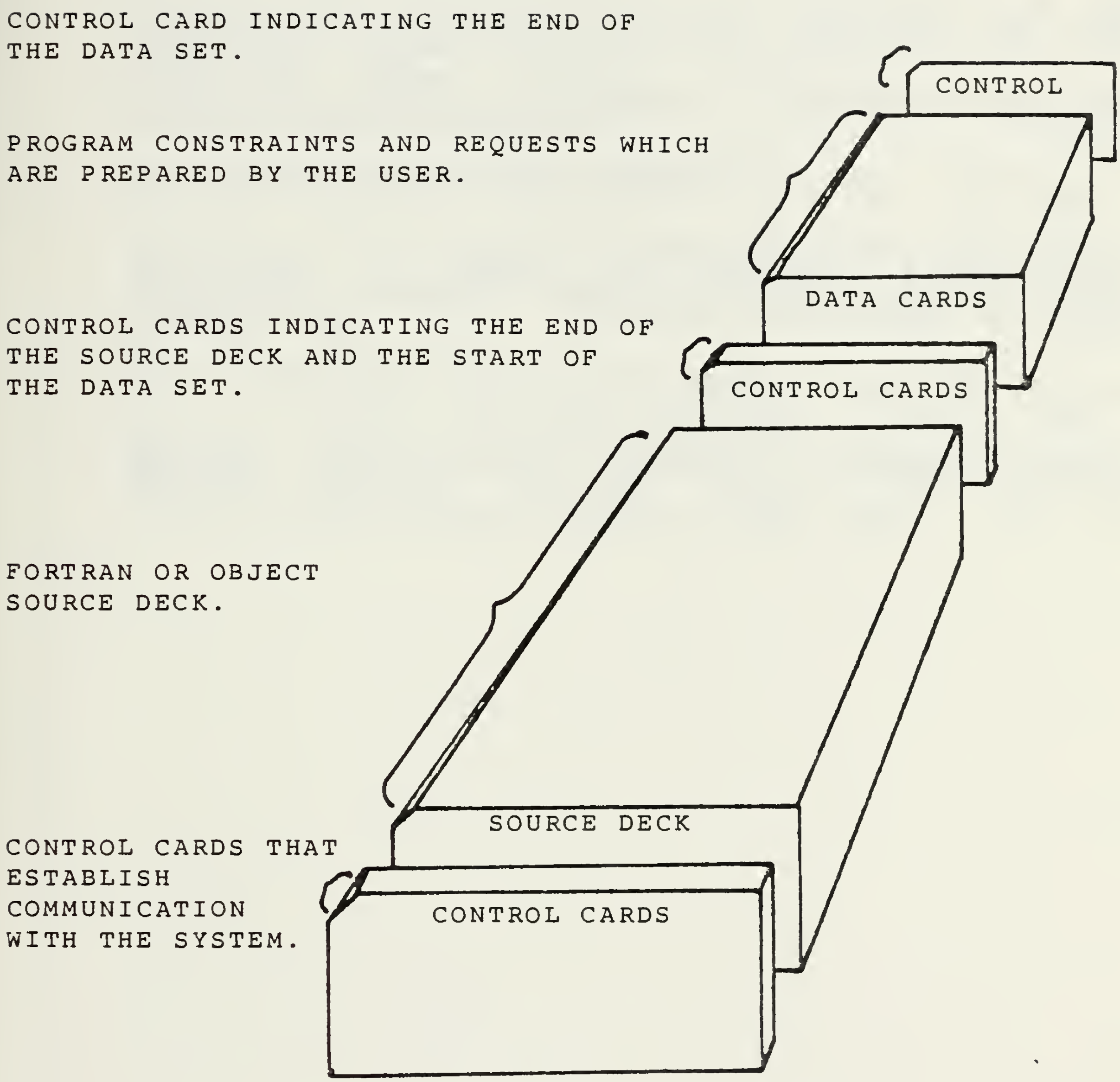

Figure 10 - THE PROPER ARRANGEMENT OF THE SCHEDULING PROGRAM DECK

LIST OF REFERENCES

1. FY 1977 Budget Execution Review, p.1.1-1.4, 6.1-6.5, V Corps, USAREUR, January 1977.

2. HQ, V Corps Unclassified Letter: AETVGF-B to All Subordinate Commands, Subject: PLL and POL Cost Factors for Training Budget, 2 March 1977.

3. Convention between Deutsches Bundesbahn and Military Forces Stationed in FRG, w/c1-31., p.121-164, Deutsches Bundesban FRG, January 1964.

4. Army Force Planning Cost Handbook, p. 634, Directorate of Cost Analysis, Comptroller of the Army, June 1976.

5. Research Analysis Corporation Technical Memorandum RAC-T-465, A Method for Predicting Repair Parts Replacement Developed from Data for M60 Tanks and M113 APCs(U), by John R. Bossenga, and others, p. 1-213, January 1966.

6. U.S. Army Europe Unclassified Message AEAGC-DT 261336Z Jan 77, Subject: FY 78 MTA Schedule, 26 January 1977.

7. European Freight Traffic Management Handbook-4th Trans Pam 55-1, w/c1-3., p.I-110-1--110-5, I-114-1--114-20, Traffic Analysis Division, JTMA, HQ, USA 4th Transportation Brigade, Europe, March 1976.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Headquarters Department of the Army Office of the Deputy Chief of Staff for Operations and Plans ATTN: DAMO-ZD Washington, D.C. 20310	1
3.	Command and General Staff College ATTN: Educational Advisor Room 123, Bell Hall Fort Leavenworth, Kansas 66027	1
4.	General Donn A. Starry Commanding General Headquarters TRADOC Fort Monroe, Virginia 23651	1
5.	Commander USAREUR ATTN: DCofS Operations APO New York 09403	1
6.	Commanding General Headquarters, V Corps APO New York 09079	1

7. Commander V Corps 1
ACofS Resource Management
ATTN: COL Socky
APO New York 09079

8. Commander V Corps 1
ACofS G-3
ATTN: COL Schroeder
APO New York 09079

9. Commander V Corps 1
ACofS Resource Management
ATTN: LTC Harrison
APO New York 09079

10. Commander 8th Infantry Division 1
ATTN: ACofS Resource Management
APO New York 09111

11. Commander 3rd Armor Division 1
ATTN: ACofS Resource Management
APO New York 09039

12. Commander VII Corps 1
ATTN: ACofS G-3
APO New York 09154

13. Commander FORSCOM 1
ATTN: DCofS Operations
Fort McPherson, Ga. 30330

14. Commander 8th Army 1
ATTN: DCofS Operations
APO S.F. 96301

15. Commander XVIII ABN Corps 1
ATTN: ACofS G-3
Fort Bragg, N.C. 28307

16. Commander III Corps 1
ATTN: ACofS G-3
Fort Hood, Texas 76544

17. Commander I Corps 1
ATTN: ACofS G-3
APO S.F. 96358

18. Library, Code 0142 2
Naval Postgraduate School
Monterey, California 93940

19. Department Chairman, Code 55 1
Department of Operations Research
Naval Postgraduate School
Monterey, California 93940

20. Associate Professor Samuel H. Parry, Code 55 Py 2
Department of Operations Research
Naval Postgraduate School
Monterey, California 93940

21. LCDR Joseph H. Cyr, Code 30 1
Department of Operations Research
Naval Postgraduate School
Monterey, California 93940

22. LTC Robert J. Castleman, Code 55Ce 2
Department of Operations Research
Naval Postgraduate School
Monterey, California 93940

23. Captain Michael John Moore, USA 1
15 Ross Street
Ashley, Pennsylvania 18706

24. Captain Thomas Joseph Teesdale, USA 1
3156 Longshore Avenue
Philadelphia, Pennsylvania 19149