AD-A065 636 ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KANS F/G 9/2
A METHODOLOGY FOR INTERFACING COMPUTERIZED COMBAT MODELS AND FI--ETC(U)
JUN 78 J R STATZ

UNCLASSIFIED NL

1 OF 2
AD
A065636

AD A0 65636

DDC FILE COPY

UNCLASSIFIED

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): A Methodology for Interfacing Computerized Combat Models and Field Experiments	5. TYPE OF REPORT & PERIOD COVERED: Final Report, 9 June 1978
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John R. Statz, Jr., MAJ, USA	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Student at the U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Command and General Staff College, ATTN: ATSW-SE	12. REPORT DATE: 9 Jun[redacted]978
	13. NUMBER OF PAGES: 123
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

LEVEL

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DDC RECEIVED MAR 14 1979 C

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

Approved for public release; distribution unlimited.

18. SUPPLEMENTARY NOTES

Master of Military Art and Science (MMAS) Thesis prepared at CGSC in partial fulfillment of the Masters Program requirements, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas 66027

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

DYNTACS, TETAM, field experiments, data collection, model verification, model improvement, computer simulation

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

This thesis discusses the lack of computer model-field experiment interfaces which evolved from the separate development of the Army's more important models and field experiments. A data schema is proposed that will help solve the problem, particularly for future experimentation and model improvement work. The type of data to be collected are defined, and their sources are identified, using common Army planning and training tools. A technique is then developed that helps describe the more important events underlying combat processes. Finally, an example problem is given that demonstrates the use of

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

50 037260

20. the technique by interfacing the data obtained from a reconstructed trial from the TETAM field experiment with the DYNTACS combat simulation model.

A METHODOLOGY FOR INTERFACING COMPUTERIZED COMBAT MODELS AND FIELD EXPERIMENTS

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

MASTER OF MILITARY ART AND SCIENCE

by

JOHN R. STATZ, JR.
B.S., Hofstra University, 1965

Fort Leavenworth, Kansas
1978

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of Candidate John R. Statz, Jr.

Title of Thesis A Methodology for Interfacing Computerized Combat Models and Field Experiments

Approved by:

____________________, Research Advisor

____________________, Member, Graduate Faculty

____________________, Member, Consulting Faculty

Accepted this 20 day of Jun 1978 by ____________________, Director, Master of Military Art and Science.

The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

Results obtained from field experiments and computerized combat simulation models are among the most important sources of data used by combat developers to design the Army of the future. Ideally, field experiments should provide combat developers with data concerning human interactions with new equipment, new tactics and new training techniques. These data would then be used as inputs to combat models for sensitivity analyses and force optimization studies. On the other hand, exploratory tests could be run on computer models to assist in field experiment design. Unfortunately, this is not always the case.

This thesis discusses this problem, which evolved from the separate development of the Army's more important models and field experiments, and then demonstrates the lack of a common data interface between them. A data schema is proposed that will help solve the interface problem, particularly for future experimentation and model improvement work. The type of data to be collected are defined, and their sources are identified, using common Army planning and training tools. A technique is then developed that helps describe the more important events underlying combat processes. Finally, an example problem is given that demonstrates the use of the technique by interfacing the data obtained from a reconstructed trial from the TETAM field experiment with the DYNTACS combat simulation model.

The methodology developed in this study supports future efforts to improve combat models through field experimentation.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (concluded)

LIST OF TABLES

LIST OF TABLES (concluded)

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

General

The development of new or improved combat equipment, tactics and force structures is an expensive task in terms of time, personnel, equipment and other resources. The combat developer can reduce this cost if he can demonstrate the relative effectiveness of new or improved systems early in their development so that limited resources can be concentrated on systems, or their alternatives, that demonstrate the highest potential payoff. Most techniques available for making this discrimination require significant amounts of data in order to differentiate among systems development options.

Data describing the operation of a new or even a hypothetical system in the laboratory or a similar controlled environment are fairly easy to obtain. However, weapon systems must be operated by humans in a hostile environment and relevant performance data of this type are not always available. Since wars of the future may be fought differently than those of the past, data obtained during past conflicts may not be applicable. Historically, many armies that have optimized their forces based on lessons learned in past conflicts have eventually met with disaster.

There are several ways to gain insights into the manner in which future wars will be fought, however. Among the possible sources of relevant operational data are map exercises, computerized combat simulation models and field experiments. Map exercises provide operational data of limited accuracy for most combat development applications outside of the relatively subjective areas of command and control. The latter two sources of operational data are widely used by combat developers. Their utility is continually increasing concomitant with improvements in computer technology.

A problem often arises when both models and field experiments are used to examine the same system, because the results may be difficult to correlate. This correlation problem is often attributable to the fact that the computer model operates on a set of state variables that is different than that examined in the field experiment. As a result, the input data requirements of the model are not satisfied to the degree necessary to achieve comparable results. Some characteristics of field experiments and computer models are discussed below.

Field Experiments

Field experiments have provided weapon effectiveness data for years. The advent of the computer and other modern electronic equipment, however, has significantly increased the capability of combat developers to both collect and process field data that describe the interactions of the human operator with the weapon systems. Still, field experiments are a form of combat simulations because some, but not all, of the processes involved in actual combat can be recorded. For example, they probably underestimate the effects of fear on the outcome of the battle. None the less, modern electronic equipment permits "real-time" casualty assessment in field experiments by the application of weapon effectiveness data to firers and their targets. Firer and target pairs, for example, can be matched using a system of lasers and laser sensors, while other equipment locates and identifies individual systems on the battlefield. The Tactical Effectiveness

Testing of Antitank Missiles (TETAM) [1] field experiment is an example of a test that used modern data collection equipment. The experiment was conducted by the US Army Combat Developments Experimentation Command between October 1971 and December 1973 at a cost of well over $1 million. The experiment had three principal objectives, one of which was to provide data to validate three of the US Army's high resolution computerized ground combat models. One of these, DYNTACS, is discussed in the next paragraph.

Computerized Combat Simulation Models

Computerized combat models are a relatively new combat developments tool. Their development has been encouraged by the fact that their application is relatively inexpensive compared to field experiments. They are particularly useful for additional experimentation, such as sensitivity analyses. On the other hand, the evolution of such models has generally been characterized by the requirement to investigate a unique system where the underlying processes were not well understood, and for which only hypothetical data existed. As a result, some of their state variables that describe the environment and characteristics of a particular system may not correspond to the real world. An example of this is the DYNTACS detection submodel. [2] DYNTACS is a large model, consisting of about 30,000 lines of FORTRAN coding. It currently requires about 1 megabyte of core on an IBM System 370-165 for an attacking battalion vs defending company scenario. Each replication takes about 60 minutes of CPU time to execute. The output of DYNTACS can be tailored to the user's needs; however, the input requirements are detailed and voluminous. It takes anywhere from six to 12 weeks for experienced modelers to set up a new DYNTACS scenario, still a relatively short time period when compared to a large scale field experiment like TETAM.

Field Experiment - Computer Model Interface

At first glance an obvious way to circumvent the cost and data collection problems associated with combat developments would be to conduct a field experiment to identify data requirements and then use the results as input to a computer model. The computer model could then be used to conduct sensitivity analyses, thus reducing the overall cost of the experiment. Unfortunately, most computer models were developed independently of field experiments and the resultant data incompatibilities are presently difficult to surmount. Some of these are discussed in chapter 4.

Scope

This paper develops techniques to reduce field experiment-computer model incompatibilities. The techniques are designed to make maximum use of data collected in the field. Since more factors are controlled in the models than in field experiments, the technique is not designed to produce precise correspondence between the two. Rather, the objective is to develop a means to rationalize the results of the two sources of operational effectiveness data. In other words, the distribution of the results should be the same in a statistical rather than in the absolute sense, permitting similar conclusions to be drawn from the results of each. Since field experiments are a computer model's most important link with the real world, the methodology is intended to introduce discipline into the data development system.

There are at least two benefits that can be derived from a more disciplined approach to field data collection. First, it provides the capability to continually build a model data base, regardless of the general purpose of the particular experiment(s) from which the data have been obtained. For example, the target detection process may not differ between two field experiments, one of which investigated new weapon system alternatives and the other of which was designed to investigate alternative tactical employment techniques for the system that was selected in the first experiment. Properly collected detection data would be used to refine detection model data bases in an evolutionary fashion. The evolving model data base would eventually be able to reproduce those rare events that may occur only once or twice in any particular experiment. Once a standardized data collection schema is established, the cost of collecting the additional data would be minimal. A second major benefit would be the capability to analyze older data from a completely different perspective; i.e., as new hypotheses are formed from data collected from other sources.

Organization

The next chapter contains a discussion of a set of data definitions. These definitions provide insights into how the different types of data should be collected. A schema for classifying and recording the data is also developed.

Chapter 3 develops a methodology for identifying the sources of data described in chapter 2. The methodology is applied to the TETAM experiment in chapter 4 and inputs to the DYNTACS model are discussed. Conclusions and recommendations are contained in chapter 5.

CHAPTER 2

TERMINOLOGY

Introduction

This chapter introduces terms that will be used in the remainder of this paper. The concept of a combat process and the activities and events that underlie a process are discussed first. Definitions of the types of data that describe an event are then given. Finally, a means for recording these data is developed.

Combat Process

A combat process is a series of activities executed by individuals and crews that are intended to conform to an operational plan. The plan is one that has been designed to achieve a goal, such as defend a position, attack and secure a position, or destroy a target weapon system. Two examples of combat processes are listed in table 1. A combat process is made up of one or more activities that take time to accomplish. Activities have a definite beginning and end, called events, with each event occuring at a different point in time. The concepts of combat processes, activities, and events correspond closely to the way these same terms are used in project evaluation and review techniques (PERT), for which there are many references in project management literature.

Activities and Events

Although it was stated above that each activity has a beginning and an end, technological shortcomings in data collection equipment may preclude the precise measurement of individual times for some

Table 1. Examples of two combat processes with associated activities and events [3]

Process	Activities	Representative Events
Preparation of Defense	Position Preparation	Start Position Improvement
		Complete Position Improvement
Weapon Engagement	Search for Target	Begin Search of Sector
		Detect Target
	Target Acquisition	Start Traversing Weapon
		End Traverse (sight aligned on target)
	Decision to Engage	Target Identification
		Check Sector and Target Priority
	Engagement (and tracking, if missile system is fired)	Fire Round
		Round Impact
	Damage Assessment	Relocate Target
		Check Effects

types of events. This is especially true for events that occur in rapid succession. The relationship between an activity and its events is illustrated in figure 1. As the difference between the firing time (t_f) and the impact time (t_i) decreases, it may become difficult to measure the length of the engagement activity ($t_i - t_f$). Thus the two events could merge to one and the identity of the activity could be lost. An example of this is a tank firing a fast round at a close-in target.

On the other hand, an engagement of a tank by an antitank missile (ATM) system would be delineated by the firing and impact events separated in time by the relatively slow flight of the missile. Because the same type of activity is occurring in either case, the capability must be provided to describe the events, even though it may not be possible to measure precisely their individual times of occurrence.

The terms process and activity will be used mainly as a convenient means of grouping several activities or events, respectively, for discussion purposes. Identifying the events that delineate an activity is crucial to a disciplined data collection effort, however. Thus, the remainder of this study is devoted to developing methods to identify and label the events that take place on the battlefield, because event labels provide a convenient means for organizing and storing data that are collected from field experiments or from computer models. The types of data that are of interest are discussed below.

<u>Types of Data</u>

For the purposes of this discussion data can be broken into two

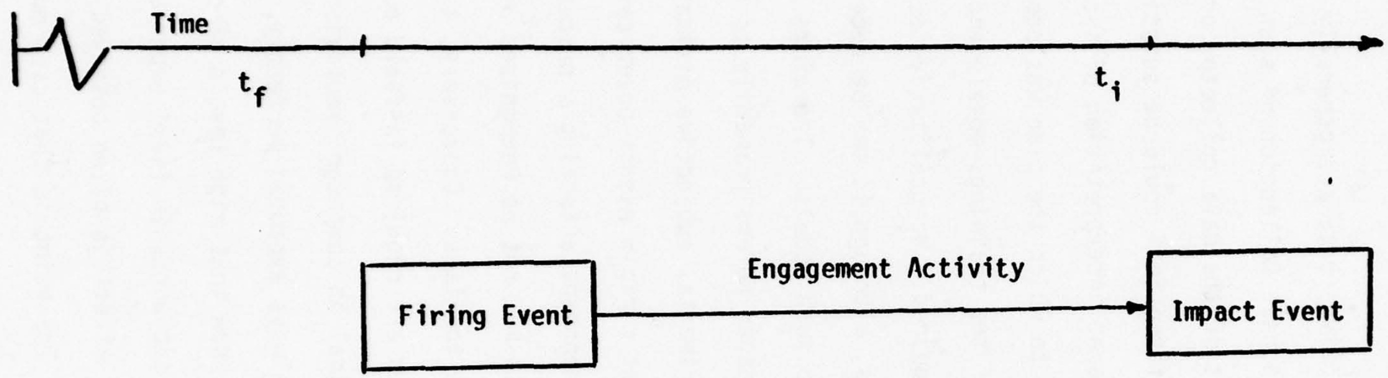


Figure 1. The relationships of an activity and its events to time

general categories; quantitative (objective) data; and qualitative (subjective) data. The importance of identifying and collecting qualitative data is often overlooked.

Qualitative Data

Qualitative (subjective) data are generally those that answer the "why" and "how" questions. Collection of such data requires a value judgment on the part of the data collector or controller of an experiment. The term "information" could be substituted for the term "qualitative data" because an interpretation of such things as the tactical plan; the degree to which the plan was properly (or improperly) executed; an evaluation of the training, morale and capability of the participants; etc., is required. No qualitative data are derived from computer simulation models, although it may be necessary to use these types of data as inputs to such models. Therefore the discussion of qualitative data in this paper refers primarily to field experiments. In large scale field experiments, subjective estimates of the conditions that exist at the time that certain events occur can be important to an understanding of the phenomena affecting a process under examination. The need for such estimates may not be recognized by the proponents of the experiment until it is too late. Conversely, the conditions for which qualitative estimates are required in field experiments are usually assumed to be optimal in computer simulations. For example, computer model plans are always executed perfectly, implying a high level of training, yet we know that high levels of performance are not always achieved by the participants in field experiments. On the other hand the "Hawthorne" effect is often observed in experiments involving human subjects. The point is that care must be exercised to at least identify the existence of such effects even if it is not possible to eliminate them. In any case a schema is required to permit such judgments to be recorded for subsequent analysis.

Quantitative Data

Quantitative data are those that are readily reduced to numerical form for mathematical and/or statistical analysis. However, it is important to recognize the source and use of such data. For example, higher levels of data, such as a vehicle's speed between two points, need not be collected when data reflecting the location of the vehicle at two different times is known, because the former data become redundant. The discussion up to this point illustrates two subcategories of quantitative data; state and derivative data. State data describe the conditions defining a particular event; e.g., the time, location and vehicle involved in a movement activity. Derivative data describe the activity by giving the vehicle speed at a certain time in the battle. If the locations of the vehicle are not recorded and derivative data are, critical information may be lost for posterity. This is particularly true if field experiment data are to be used as computer model inputs because average speeds are meaningless to most high resolution models of any interest, if the location of the vehicle is not also known. On the other hand, if the basic location and time data are recorded then the computation of the average speed is a simple matter. A third subcategory of interest will be called characteristic data. Characteristic data describe the performance characteristics of a system. This term may be somewhat ambiguous because data in either of the other subcategories can also be classified as characteristic, depending on the situation under investigation. For example, the probability of hit for a direct fire system engaging a target can be either mathematically modeled or obtained from tables. In either case it is characteristic data and is used to facilitate the collection of the results of the engagement. On the other hand, if the purpose of the experiment is to determine the accuracy of a system through firing tests, then the actual impact point of the individual round is a state datum and the computed probability of hit or kill from several firings are derivative data. The relationship between the various types of data defined above are illustrated in table 2 for the firing activity in an engagement process. The illustrated activity consists of two events; a firing event and its attendant impact event. The data answer the questions who, what, where, when, and why of the events and thus describe what occurred.

Data Collection

It was pointed out in the first part of this chapter that combat processes, such as the antitank missile engagement process, can be envisioned as a series of events and activities. Both quantitative and qualitative data can be used to describe these events and activities. The many uses to which test data can be applied subsequent to an experiment beg a consistent and simple data formating system. At least equally important is the requirement to identify the events and activities for which data must be collected. Recent studies have indicated serious shortcomings in both the fidelity of combat process representation and the compatibility of many of the US Army's most widely used combat models.[4] While many of these models are event-sequenced, the types of events that are used in one model are not necessarily those used in one or more of the others. This fact is

Table 2. Example of events and data elements in a firing activity or an engagement process

	Firing Event Data Elements			Impact Event Data Elements			Qualitative Data
	State	Characteristic	Derivative	State	Characteristic	Derivative	
Participant #1 (firer)	Location (x,y,z) Time Visibility conditions	Weapon type[1] Ammo type[1] Time of flight of round Max range of round Probability of hit[2] Sector of fire	Speed Rounds remaining Accuracy[2] Effectiveness[2]	Location[3] Time[3]			Target Priorities Objective Level of training Motivation Scheme of Maneuver Knowledge etc.
Participant #2 (target)	Location Time Line of sight exist[3] Exposure Camouflage[4]	Target type[1]	Relative speed Range	Location Time Exposure state (aspect presented to firer, % of hull exposed, etc.)	Vulnerability	Range Type of Kill (% damage)	Same as above

1. Could also be state data if only one weapon/ammunition type on each side can be implied.
2. If this type data can be measured directly, then it is state data. If it is computed or monte carloed it is characteristic data.
3. May only be required for certain types of firing events (e.g., ATM).
4. May be qualitative data (e.g., a subjective estimate of difficulty of detection).

demonstrated in table 3 for one process, antitank guided missile engagement. The remainder of this chapter contains a description of an event classification system that is designed to overcome the problem of state data incompatibility by providing a classification schema. The schema can be expanded to keep up with advancements in the state of the art of ground combat field experimentation and to facilitate improvements to combat models. While this classification schema is primarily intended to handle quantitative data, provisions will be made to apply certain qualitative estimates to appropriate data points. A list of events that are important to the engagement processes of tanks and ATM is included for illustrative purposes. Some desirable characteristics of an event classification schema are stated in the next paragraph.

Desired Characteristics of an Event Classification Scheme

The philosophy underlying the scheme presented below is that it should facilitate the complete reconstruction of the individual trials of the experiment from which the data were collected. One important application of such a reconstruction is a computer graphics playback of the major events of each trial for either training or data analysis purposes. Since advancement of the state of the art of computerized combat modeling is a goal of several US Army agencies [5], the classification scheme must provide a complete, and unique, set of state data for each trial commensurate with the data collection equipment available. This will facilitate further examination of underlying processes and permit trials from different experiments to be compared, even though the number and accuracy of the data points may vary widely. Finally, the schema must make provisions for the collection of all the

Table 3. Model treatment of the antitank guided missile (ATGM) system engagement process [6]

Process	Carmonette	DYNTACS-X	BLDM	TRACOM
Establishment of intervisibility	Yes	Yes	Pre-processed	Pre-processed
Detection:				
Firing-cued	Yes	Yes	No	Yes
Non-cued	Yes	Yes	No	Yes
Acquisition	Yes	Yes	Yes	Yes
Identification	No	Yes	No	No
Range estimation	No	No	No	No
Decision to engage (except target selection procedure)	No	No	No	No
Crew procedures during missile flight time	No	No	No	No
Gunner tracking error	No	No	No	No
Impact of damage assessment on decision to fire again	Yes	Yes	No	No
Reload	Yes	Yes	Yes	Yes
Evasive action	No	No	No	No

categories and subcategories of data described previously with the exception of derivative data, considerations for which are discussed next.

Transfer Functions [7]

Derivative data are obtained from state data (hence the name) and one way of visualizing this is shown in figure 2. The box in the figure represents the function for calculating the distance between the two points (x_1, y_1) and (x_2, y_2) for a vehicle i. These inputs to the transfer function are shown by the arrows on the left. If the times that the vehicle left point one and arrived at point two are known, then the speed of the vehicle can be derived as shown.

An event classification scheme should facilitate computations of the type shown on the inputs to the transfer function. This is accomplished by selecting a format that can be applied consistently to all state data of interest. Considerations of characteristic and qualitative data are equally important since the concept of the transfer function can be easily modified to handle these types of data through the use of decision tables. This subject is addressed later in this chapter.

Data Vector

The general form of the data vector that will be used to classify and store the quantitative and qualitative data that will be identified in the following chapters is:

$$e_k(i,j,x,y,z,R_{kl},C_{kl})$$

where

k = event type

R_{kl} = the set of possible values for the results of each type of event

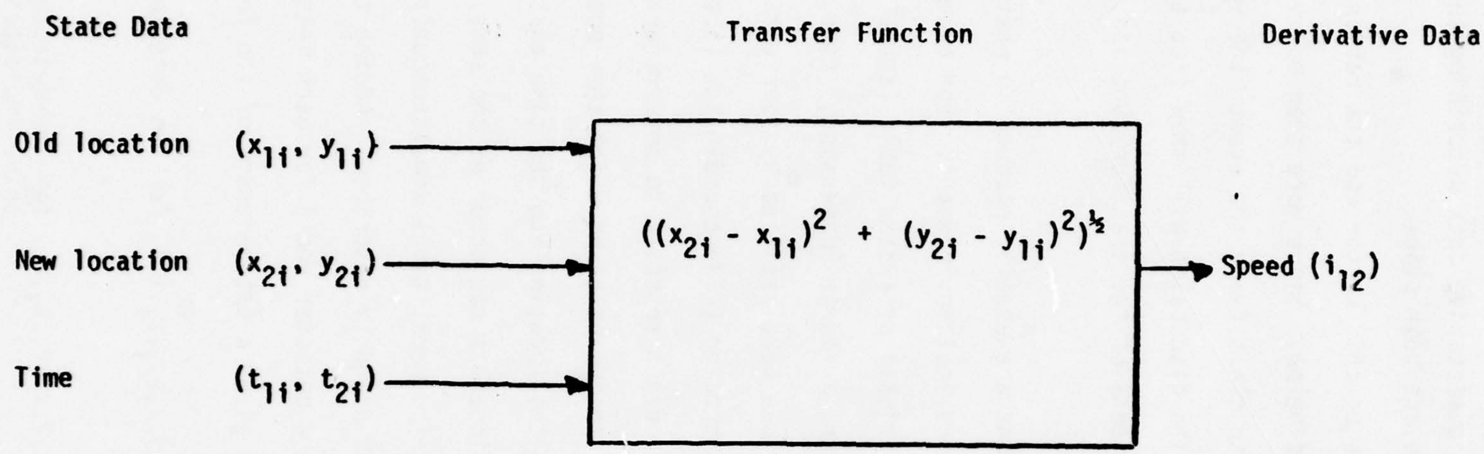


Figure 2. Transformation of state data to derivative data for vehicle i

C_{kl} = the set of qualitative data describing the conditions under which the event took place.

The elements that make up this vector and the rationale for their solution are discussed below. Since more than one value of R_{kl} and C_{kl} may be important to classifying the event, the vector e_k may be of variable length. The discussion will show that the form of e_k satisfies the requirements of the transfer function described above.

Data Vector Elements

Combat operations are usually planned in what could be described as a two or three dimensional environment. For example, plans are made using a map (two dimensions) or a sand table (three dimensions). As the actual events occur, a fourth "dimension," time, is added. Thus combat events usually can be classified by four variables: the time, Universal Transverse Mercator (UTM) coordinates (i.e., x and y coordinates); and the height relative to some reference such as sea or ground level (the z coordinate) at which they occur. Therefore, $e_k(x,y,z,t)$ describes the location and the time that an event occurred. Since many events of interest can occur at the same time and location (e.g., the detection of several tanks simultaneously by one observer) the event k is not yet uniquely described. Adding the identity of the participants, i for the detector and j for each detectee to the classification scheme gives a data element of the form

$e_k(i,j,x_i,y_i,z_i,t_i)$ for the detector

and $e_{k'}(j,i,x_j,y_j,z_j,t_j)$ for the detectee (where the k-prime indicates the occurrence of the complement of the kth type of event).

Figure 3 illustrates this scheme for two simultaneous firings by tanks A and B at C. If k = 1 for a firing event and k(1)' = 2 for an impact event, then four events, two firing and two impact, take place as follows:

$$e_1(A,C,x_A,y_A,z_A,t_A)$$

$$e_1(B,C,x_B,y_B,z_B,t_B)$$

$$e_2(C,A,x_C,y_C,z_C,t_C)$$

$$e_2(C,B,x_C,y_C,z_C,t_C)$$

where $t_C = t_A$ + time of flight of the round.

The subscripted notation can quickly become cumbersome, so the assumption will be made that the x,y,z and t of an event always refers to the participant listed next to the left parenthesis. It may appear that important data are missing from the above list; e.g., the location of the target C at the time the firings occurred. This problem is circumvented by requiring that a basic type of event be recorded as often and as accurately as possible. This event, called the location event, k = 0, describes the tactical geometry of the battlefield over time, and is critical to an understanding of what transpired. A location event for each participant in the experiment should be recorded every time an event for one participant is recorded. This may be difficult to accomplish unless automatic data processing equipment are available. The event is now categorized as:

$$e_k(i,j,x,y,z,t)$$

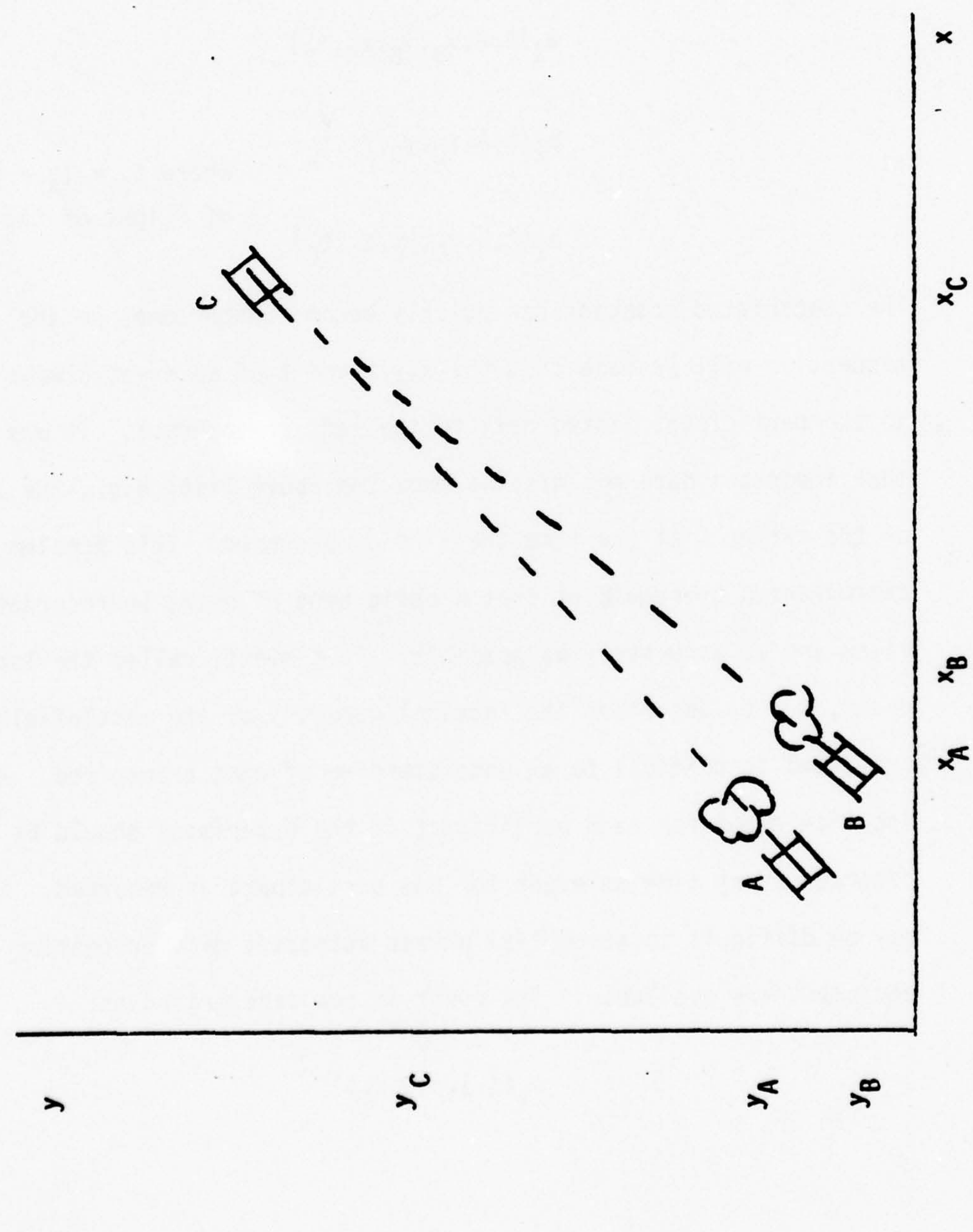


Figure 3. Two simultaneous firings

$i = 0,1,2,3 \ldots, n$ where n = total number of participants on one side

$j = 0, n+1, n+2, \ldots, m$ where m = the total number of participants on the opposing side.

$$k \geq 0$$

If we assume that is is the firer and j the target, any permissible value of i or j can occur in the second (target) position of the vector, thus accounting for the possibility of one player firing at another member of his own force.

Note that there will be no other participant in a player's location event. In order to accommodate this phenomenon, i or j assume a value of zero when k = 0. This leads to the following important subcategorization of events.

Subcategories of Events

Table 4 lists some examples of events that are commonly associated with ground combat. The bottom portion of the table contains events that require two participants. For instance, a true detection event requires both a detector (e.g., antitank missile gunner) and a "detectee" (e.g., an enemy combat vehicle, weapon, soldier, etc.). The top portion of the table lists different types of events for which there need be only one participant. This distinction is made in order to meet the requirement that the classification scheme be able to assign a unique label to each event. Another type of event is shown in the top table. The spurious, or false event, takes into account those events in which there may or may not be two participants, but in which case the second participant cannot be identified; e.g., a detection of movement when the source of

Table 4. Examples of events that occur in combat processes

Events that Require only One Participant
Movement
Maintenance/Breakdown
Reload/Resupply
Minefield Emplacement/Activation
False Event
Events that Require Two Participants
Detection
Acquisition
Identification
Range Estimation
Firing
Impact/Abort (missiles)
Damage Assessment
Communication

the movement cannot be specifically attributed to any particular participant. (Conversely, there may not have been anyone to detect, in which case a "false" detection may be said to have occurred.) Such events are known to occur on the battlefield and thus must be considered in the classification scheme.

Event Conditions

The types of data discussed earlier give some useful insights into the value of the classification vector. Note that the vector now can be used as input to transfer functions. Functions of this nature can easily transform state data into derivative data. However, the requirement for completely describing the conditions under which events such as those listed in table 3 occurred has not yet been fulfilled. For example, the visibility conditions under which the firings illustrated in figure 3 took place may be of critical importance if a new weapon sight is under investigation. Certain qualitative estimates, such as levels of training or the effects of player learning, may also have an important bearing on the event. Finally, in the case of a firing, the result of the impact is critical to future events. Therefore, the schema is modified to accommodate these types of data in a straightforward manner through the application of decision tables. To accommodate this, the data element format is expanded to its final form:

$$e_k(i,j,x,y,z,t,R_{kl},C_{kl})$$

where R_{kl} is the permissible set of results (characteristic data) for event type k. Table 5 gives examples of representative codes.

C_{kl} is a pointer to subjective estimates (qualitative data) of

Table 5. Some examples of firing conditions (k = 1)

ℓ	Condition	Permissible Values of $R_{1\ell}$
1	Round Type	1 = HEAT
		2 = APDS
		.
		.
		.
		N = White phosphorous
2	Visibility	(in meters)

Some examples of impact results (k = 2)

ℓ	Condition	Permissible Values of $R_{2\ell}$
1	Type Kill	0 = Miss
		1 = Mobility Kill
		2 = Firepower Kill
		3 = Mobility and Firepower Kill
		4 = Catastrophic Kill
	(or)	
1	Percent Kill	0 ——— 100
	Miss	101
	.	
	.	
	.	
	Lost Round	110

interest to experimenters and need not be constrained to a fixed set of references. For example, the m^{th} value may refer to a detailed narrative of a particular event, similar to a footnote on a page of text. On the other hand, it can refer to forced-choice selection of qualitative descriptors developed prior to the execution of the experiment, a photograph of defensive positions and/or debriefing forms (see table 6).

A major difference between the information contained in the R vector and the C vector is the time at which the data are added to them. Elements in the R vector are usually added in real time in highly automated systems because they contain values used in the casualty assessment process and are therefore already available. On the other hand, comment data such as that shown in table 6 will usually be added post-trial unless some provision is made for real time insertion, probably an expensive proposition.

Measures of Performance

The data collection schema just described provides some interesting benefits. For example, a simulation experiment, whether conducted in the field or on a computer, can be summarized quite easily using transfer functions. With the data vector as input, useful statistics can be obtained using functions such as those shown in table 7.

Measurement Precision

The results or conditions that occur during an event can be recorded as precisely as required. Measurement accuracy of the results or conditions can vary significantly based on the purpose for which the data are being collected, and particularly the means that are being

Table 6. Examples of qualitative data for an impact event (k = 2)

ℓ	Condition	Permissible Values of $C_{2\ell}$
1	Player Training	1 = Good 2 = Average 3 = Poor
2	Photograph Available?	1 = Yes 2 = No . . .
3	Controller Comments Available?	0 = No 1 = Trial Notes 2 = Voice Tape . . .
4	Debrief Available?	0 = No 1 = Trial Notes 2 = Voice Tape . . .
5	Were Actions Intentional?	0 = No 1 = Yes 2 = Comment in Trial Notes 3 = Don't Know . . .

Table 7. Examples of summary statistics calculated from the data vector

	Statistic	Function	Notes
1.	Initial force ratio	$\sum_i e_o \Big/ \sum_j e_o \Big\vert_{t = 0}$	e_o = location event at start of battle
2.	Loss exchange ratio	$\sum_i e_o (\ldots [R_{2\ell}]_{max} \ldots) \Big/ \sum_j e_2 (\ldots [R_{2\ell}]_{max} \ldots) \Big\vert_{0 \le t \le t_{max}}$	The highest value of $R_{2\ell} > 1$ for the impact event (e_2) would be used. More than one kill of the same type would be ignored.

used to collect them. Thus the model can be widely and consistently applied, whether the data are being collected by accurate electronic means or by hand. For example, location data can be collected by electronic ranging equipment every 1/10 of a second, or by numbered blocks of wood thrown off the back of a tank every 15 minutes and then surveyed in. The only rule that must be adhered to closely is that there must be sufficient resolution in the clock to discriminate between two similar events involving the same participant(s). For example, it must be possible to uniquely identify two firing events by the same stationary firer at the same stationary target that occur nearly simultaneously. In practice this requirement should not be difficult to meet.

Summary

Several definitions were provided in this chapter and the relationships between different categories of data were discussed. A schema for data collection and classification was then advanced to handle these data and some of its attributes were noted. The next chapter contains a description of a way to identify events and processes.

CHAPTER 3

EVENT IDENTIFICATION AND DATA REQUIREMENTS

Introduction

Previous chapters contain discussions of the kinds of data that describe the events that occur in small unit combat. There are an infinite number and variety of such events and not all of them are important. Therefore, identification of all the events or all the processes that these events delineate is beyond the scope of this discussion. However, the Army is constantly searching for ways to measure the effectiveness of training, weapons, and tactics, and there are certain processes that continually recur as subjects for investigation. One area, that of weapons engagement effectiveness, will be examined herein to illustrate a technique for identifying the events that underlie many combat processes, and further, for identifying the data that describe these events.

Over the years, the Army has attempted to identify the steps required to efficiently plan and execute combat operations. These steps have been reduced to checklists that are a useful starting point in identifying the major processes that experience has shown to be important in such operations. First, however, it may be helpful to examine briefly the elements of a tactical plan from its inception, on through its execution and a' posteriori evaluation.

Elements of Planning

One way of looking at the tactical planning cycle is shown in figure 4. The figure shows that the tactical situation is influenced

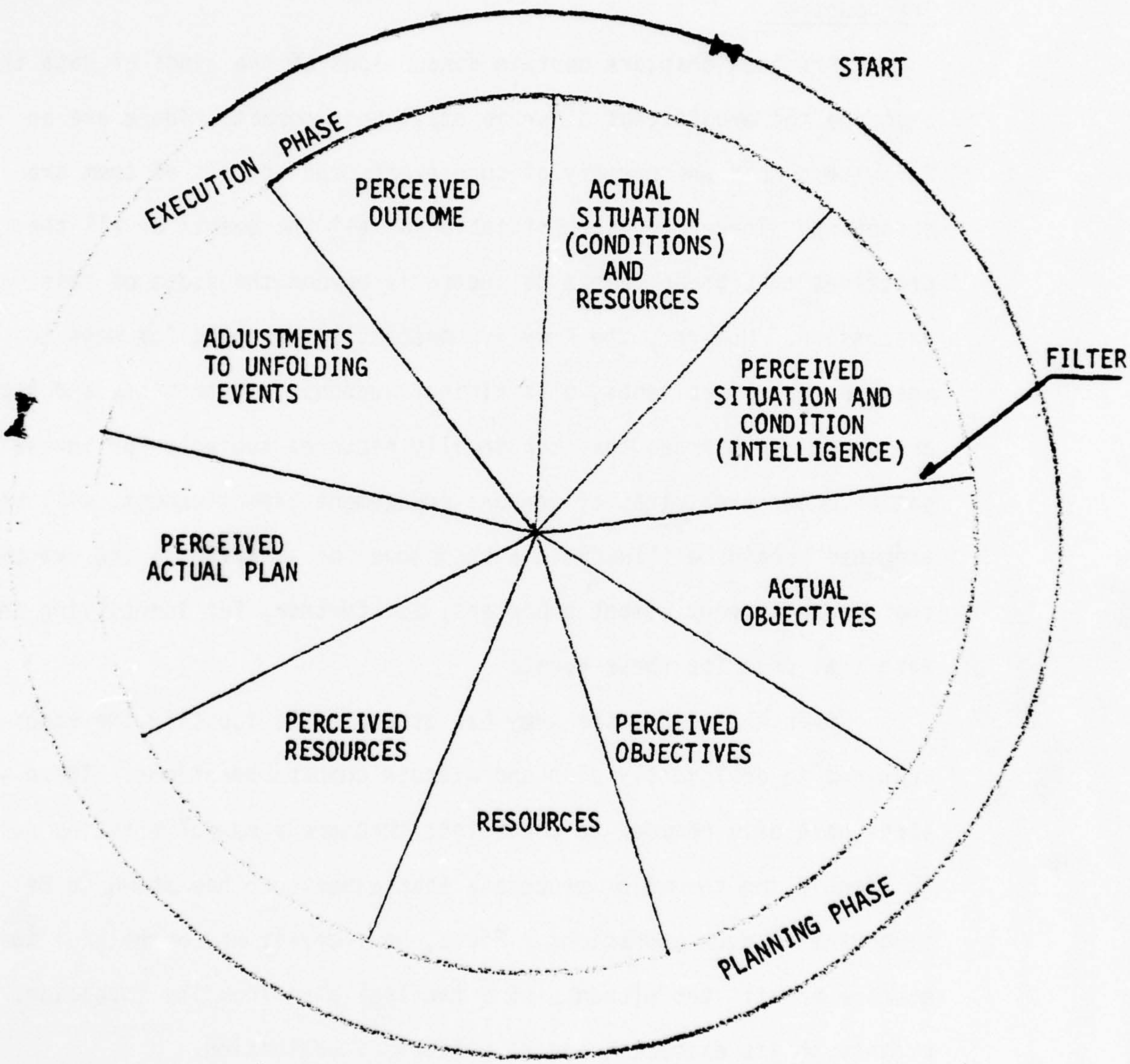


Figure 4. Elements of tactical situation

by many different perceptions. It is made up of the actual battle conditions or objectives, and these same conditions or objectives as they are perceived by the participants. Thus, while a plan may be excellent, it is only as good as the planner's perception of the actual situation, objectives of the commander, and resources available. Similarly, the execution of the plan can only be as good as the subordinate's understanding of both the commander's plan and the actual situation as it unfolds around him. A clockwise examination of the figure shows that there are many filters, or obstacles, to a complete understanding of an operation. As a result, examination of one part of the pie, e.g., the execution phase, requires an understanding of the external as well as the internal circumstances that preceded it.

In field experiments, as in actual combat, it is unlikely that anyone will be able to capture all the information that is required to describe the environment completely. However, field experiments by their very nature and purpose lend themselves to a more explicit recording of the conditions under which they occurred than is possible in combat. With proper planning and instrumentation, it is possible, figuratively as well as literally, to take "snapshots" of the situations as they unfold. The important concept illustrated by figure 4 is that the reasons for a particular series of events to have occurred must be anticipated and recorded in as much detail as possible by data collectors so that the variables that effect the performance of the system can be identified and measured. These variables can be manifold: training, equipment effectiveness, morale, etc. Helpful information that can be provided by standard Army planning and execution tools such as debriefings, operations orders, and results of reconnaissance activities must be available when needed to perform qualitative evaluations of data.

A lack of this information reduces the value of the quantitative data because the very important question of "why" events unfolded as they did cannot be answered even though the "when," "where," and "who" can be. As a result, it becomes nearly impossible to determine if events occurred because of weapons system capabilities or shortcomings, tactics, training, weather, motivation of the participants, etc. Most field experiments are far too expensive in terms of both time and money to permit blocking of all these variables in a classical experimental design, therefore the statisticians are left with relatively useless data, or data that cannot be exploited for uses other than the relatively narrow area for which the experiment may have been designed.

Qualitative Data Collection

Many of the problems in interpreting the data obtained from field experiments can be minimized by recording the information available to the participants as they execute the plan. Table 8 contains a list of the types of documentation normally generated to support combat operations. Some of these documents (denoted by an asterisk) are seldom generated for small unit operations, but there is no reason why they could not be. The documents are flagged with an "X" in the columns that indicate the types of general information thay they provide. The comment "voice tape" in the recording media column refers to the requirement to capture this information on a voice tape recorder, since this information is seldom recorded formally during an operation.

Table 8. Qualitative data available from standard US Army planning tools

Operational Training and Execution Tools / General Information Available	Participants and Capabilities (Who)	Action to be Taken (What	Location of Kill Zones, Weapons, and Other Participants (Where)	Time of Event (When)	Fire Commands, Target Priorities, Signals (How)	Training	Friendly & Enemy Situation, Tactics (Why)	When Used	Recording Media
Field Manuals, ARTEPs, SQT		X				X	X	Prior to Operation	N/A
Analysis of Area of Operation*			X					Prior to Operation	Document (standard format)
ARTEP, SQT Scores	X	X				X	X	Prior to Operation	Document
Estimate of Situation* (Reconnaissance)		X	X				X	Prior to Operation	Voice Tape, Document (Standard Format)
Operations Order	X	X	X	X	X		X	Prior to Operation	Document
Fragmentary Order	X	X	X	X	X		X	During Operation	Voice Tape
Fire Plan (Artillery, TACAIR) Range Cards	X	X	X		X		X	Prior to Operation	Document (Standard format)
Weather Data				X			X	During Operation	Document
Maintenance Records	X			X			X	During and After Operation	Document
Debriefing	X	X	X	X	X	X	X	After Operation	Voice Tape, Document

*Not usually required at battalion level and below

Note that by the definitions of chapter 2, both qualitative and quantitative information is highlighted in the table. Because of their general rather than specific nature, these documents provide information rather than data. For example, the operations order (OPORD) gives the time that an attack is to take place; i.e., the time the line of departure is to be crossed (LD time). In the actual execution of the attack, however, many factors could cause the LD time to be missed. Among these are units getting lost, vehicle breakdowns, confusing signals, spoiling attacks by the opposing force, or poor weather and trafficability conditions. Factors such as these influence the conduct of the operation, yet are usually unforseen at the sime the OPORD is published. Therefore only general information concerning the battle is obtainable from these sources and the data describing the individual events must be measured as the events occur. Thus actual LD time is a data point, while the planned LD time is information to be evaluated as necessary to analyze the operation. This point is made here because the remainder of this chapter contains a discussion of how quantitative data can be measured.

Quantitative Data Requirements

Once the importance and availability of qualitative data are determined and provisions have been made for their collection, the data collection design effort can be focused on the quantitative questions; obtaining specific data on the what, who, where, and when of each event.

A more specific representation of the tank-antitank missile (ATM) firing process than has been discussed thus far is illustrated in figure 6. The process description in the figure was developed to support a discussion of the use of computerized combat models to support training effectiveness analysis. The value of the example lies in its detailed representation of the firing process. Many other such lists can be developed from Army Training Effectiveness Program (ARTEP) checklists, Soldier Qualification Tests (SQT), etc. Once the specific individual activities are identified, data collection media can be selected that provide data of sufficient accuracy to insure that appropriate mathematical and statistical analysis techniques can be applied.

The activities and events of the ATM engagement process represented by figure 5 are discussed below. A similarly detailed analysis of other combat processes should be developed prior to the conduct of an experiment.

The ATM Engagement Process [8]

The combat effectiveness of the ATGM is a function of the capability of the weapon, the proficiency of the individual gunner and crew, and the tactics and techniques by which the commander employs the weapon. The ATGM engagement sequence embodies weapon capabilities, gunner and crew proficiency, and tactics and techniques of employment. Some of the procedures that might be involved in a typical ATGM engagement sequence are as follows.

1. Position selection and preparation. After receiving a mission assignment, generally consisting of a principal direction of fire and the left and right limits to the sectors of fire, an ATGM crew must prepare its position and clear fields of fire so that the ATGM can cover by fire as much of the assigned sector as possible. The crew must also insure that their position is camouflaged from view of the attacking weapon systems. In essence, the objective of this task is to maximize the ATGM system's intervisibility with the threat force while minimizing its detectability by the threat. The crew will also be directed to prepare withdrawal routes and alternate and supplementary positions.

2. Target detection. In the defensive posture, the ATGM gunner and crew generally can expect to be alerted to the approach of enemy armored elements. Thus, visual detection may be non-cued but is more likely to be cued by such means as the appearance of smoke and

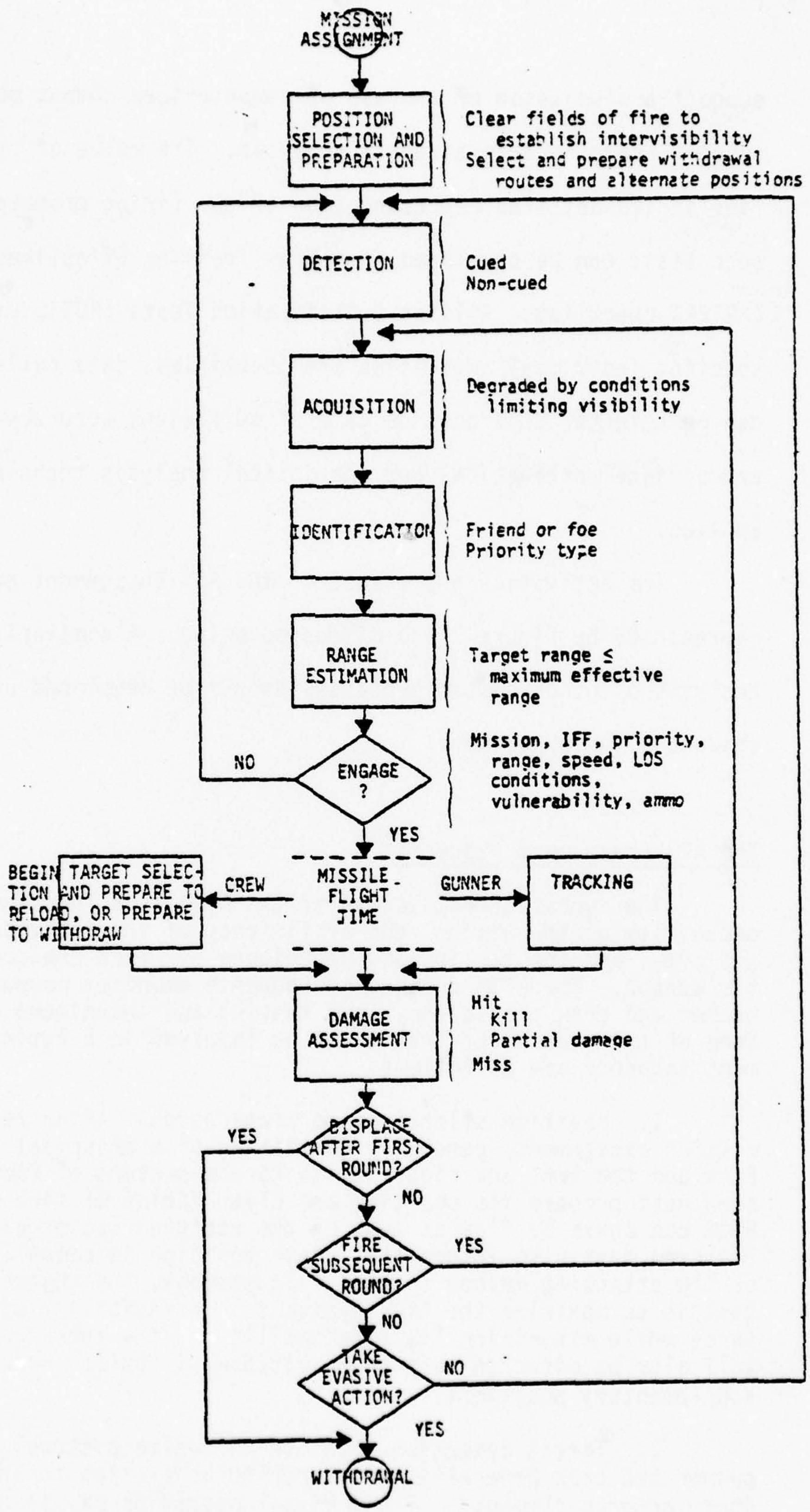


Figure 5. Typical antitank guided missile (ATGM) system engagement process [8]

dust on the battlefield, noise inherent in the movement of armored vehicles across the terrain, or engagements by threat vehicles of other elements on the battlefield.

3. Target acquisition. Having detected a potential target, the ATM gunner attempts acquisition by placing the crosshairs of the weapon's sight on the target. This process may be degraded by any visibility-limiting condition such as darkness, rain or snow, smoke, dust, or haze and may also be affected significantly by suppressive fires on the gunner.

4. Target identification. Once a target is acquired, the gunner must identify the target vehicle. Through this process, the gunner must distinguish between elements of the friendly and threat forces as well as between higher priority and lower priority targets. Both combat experience and field experiment results have shown that an attacking force does occasionally fire at its own elements. With new defensive tactics, which permit defensive units to maneuver in depth on the battlefield, identification-friend-or-foe may become a problem for the defensive force as well as the attacking force.

5. Range estimation. To realize their effectiveness potential, ATGM systems must be fired at or near their maximum effective ranges. The ATGM systems are relatively soft compared to armored vehicles, and their principal advantage over those vehicles is the long effective range of the missiles. On the other hand, the missile is ineffective when fired at a target not within the effective range of the system. Consequently, the gunner's estimation of whether the acquired target is within range is critical both to the success of the individual engagement and to the effectiveness of the ATGM system in the battle.

6. Decision to engage. The decision to engage the target or to hold fire is a judgment made in consideration of several factors. The identification of the target vehicle as friend or foe is critical, as is recognition of the type vehicle according to its priority. A correct range estimation at maximum range is crucial. Other factors to be weighed include the assigned mission, the line-of-sight characteristics of the firer position and field of fire, speed of the target, and the increased vulnerability to detection resulting from firing the mission. The basic load of missiles is an additional consideration, since the crew may need to conserve enough ammunition to permit then to disengage from the battle and perform other missions.

7. Missile flight time. Once the gunner fires, the other members of the ATGM crew are not able to influence the engagement process significantly, other than to abort it, until the missile impacts. The system is unresponsive during this relatively long time of flight, approximately 5 to 15 seconds. The crew, however, may be able to detect and select other targets while the current target is being tracked. On the other hand, the ATGM may be so detectable after firing that movement from the current firing position to an alternative firing position will be required after each round. In this case, the crew can prepare to evacuate the position upon missile impact.

8. Tracking. While the crew is carrying out its crew procedures, the gunner tracks the target. The difficulty of this task is compounded in those situations where the gunner is required to fire at targets moving through intermittent vegetation on the battlefield. In this type engagement, the gunner must try to track the target through trees and terrain masking. He must also be aware of the characteristics of the specific type ATGM being fired to insure that the tracking rate is within the specifications of the system.

9. Missile impact and assessment of damage. The assessment of damage caused by the impact of the missile on the target is a critical part of the engagement procedure. There may be a significant impact signature, but a target may not explode or burn immediately upon missile impact; thus, at long ranges the crew may not be able to make an immediate assessment of damage to the target. Consequently, the crew must be prepared to fire a subsequent round at the target or to move out and engage the target from another position. The basic load of the ATGM carrier may be a critical factor in this decision process.

10. Reload. Reloading can take place at some point in the move to a subsequent position or immediately upon impact of the missile round. A short reload time becomes significant when the target is an immediate threat to the ATGM launcher and crew.

11. Evasive action. Decisions must be made as to whether sufficient rounds have been fired from the position for it to have been identified and, if so, whether to take evasive action. Field experiment results have shown that weapon systems may be most detectable and vulnerable when they are moving out of firing positions. Thus, accomplishment of this task relates directly to the preparation of the position accomplished in the first task above. Prepared withdrawal routes may be critical to system survival.

Identification of Quantitative Data Requirements

Table 9 contains a list of data elements, primarily quantitative, that describe the activities and events of the ATM engagement process described above. The large amount of data required and the relatively tedious computations required to transform them suggest that automatic data processing equipment be used. Further discussion of this subject will be deferred until the next chapter.

Summary

Sources of qualitative data and some quantitative data requirements were identified in this chapter. A detailed example of one combat process, the antitank missile engagement process, was provided.

Table 9. Quantitative data required to describe ATM engagement events/activities

	Descriptive Data \ Activity and/or Event	Position Selection & Preparation	Target Detection	Target Acquisition	Target Identification	Range Estimation	Decision to Engage	Missile Flight	Missile Tracking	Impact Damage Assessment	Reload	Evasive Action
1.	Participant(s)	X	X	X	X	X	X	X	X	X	X	X
2.	x,y location time	X	X	X	X	X	X	X	X	X	X	X
3.	Principal direction of fire	X	X									
4.	Left and right limits of sector	X	X	X	X	X	X	X	X	X		X
5.	Exposed area of weapon/vehicle		X	X	X	X	X		X	X		
6.	Degree of Camouflage		X	X	X	X	X		X	X		
7.	Killing zone location		X	X	X	X	X		X	X		
8.	Crew training, proficiency	X	X	X	X	X	X		X	X	X	X
9.	Cue (smoke, noise movement, firing)		X									
10.	Uncued (search pattern, sector)		X									
11.	Light levels		X	X	X	X	X		X	X		X
12.	Vision aids (power, field of view)		X	X	X	X	X		X	X		
13.	Estimated range		X	X	X	X	X	X	X	X		X
14.	Target priority, engagement rules						X					X
15.	Basic load, remaining load						X					X
16.	Time of fire, impact							X	X	X		
17.	Missile reliability, effectiveness							X		X		
18.	Estimated/actual results									X		X
19.	Round type						X			X		

In addition, data describing the events underlying this process was identified. The information provided will be used in the next chapter to analyze a battle (trial) from an actual field experiment.

CHAPTER 4

AN APPLICATION

Introduction

The data model developed in chapter 2 and the activities and events identified in chapter 3 were discussed in terms of their utility in facilitating data collection in future field experiments. Event identification and data classification techniques are particularly applicable for field experiments that are designed to produce input to, or improve submodels for computerized combat models, because qualitative data can be transformed rather easily into mathematical relations describing the manner in which combat operations take place.

There is an additional benefit that can be obtained from the data collection philosophy espoused in the earlier chapters. That is, field experiment trials already conducted but incompletely documented can be reconstructed in order to obtain broader estimates of what occurred. The purpose of this chapter is to illustrate the application of the techniques described earlier by interfacing the Tactical Effectiveness Testing of Antitank Missiles (TETAM) field experiment and the Dynamic Tactical Simulator (DYNTACS) computer model.

The TETAM Experiment

This experiment was designed to examine the effectiveness of antitank missile systems and to provide data with which to validate several important subroutines in three stochastic computer models of ground combat. A major stumbling block to the realization of the latter objective is the fact that the data provided in the published experimental results does not, in many cases, match that used in the models. Figures 6 through 8 demonstrate the manner in which the results of the antitank engagements of the field experiment were published. Tables 10 through 12 show other engagement data available from the published results. An examination of these data elements shows that with the exceptions of figure 8 and table 12, they are derivative data in the sense of the definitions of chapter 2. The state data that are available are insufficient for model setup purposes, as will be pointed out below.

DYNTACS

Table 13 lists some input variables in the applicable ATM subroutines of DYNTACS, one of the highest resolution models in the Army inventory. The lack of comparability between the data collected in TETAM and the data required as input to DYNTACS supports the contention that state data are required for models, not derivative data. Thus the problem to be resolved is one of developing input data from the experimental results that are available. A method for doing this is given below and utilizes information such as that identified in table 9. The data schema described in chapter 2 is used to process those data that were identified.

General Approach

Note that the data shown in figures 6 and 7 were accumulated over many trials (replications) and are therefore, at best, average results. Examination of time-line data for each trial indicates that there are large time disparities between the occurrence of many events, between trials (see reference 11). This raises the question of the validity of averaging the results of some of the trials.

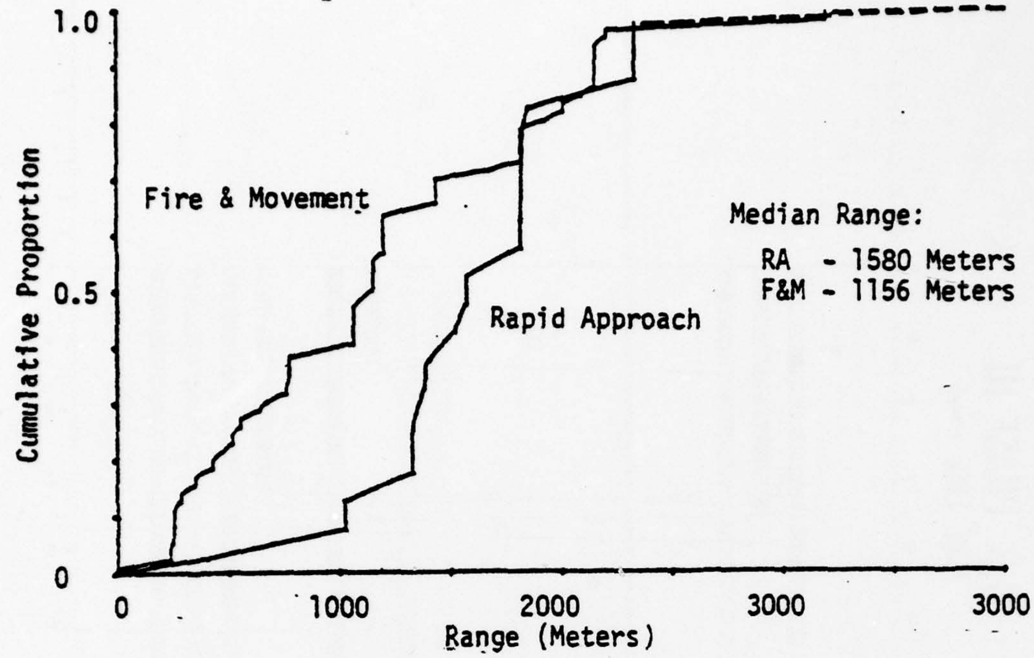


Figure 6. Cumulative proportion of attacker engagement ranges for each tactic on site A[9]

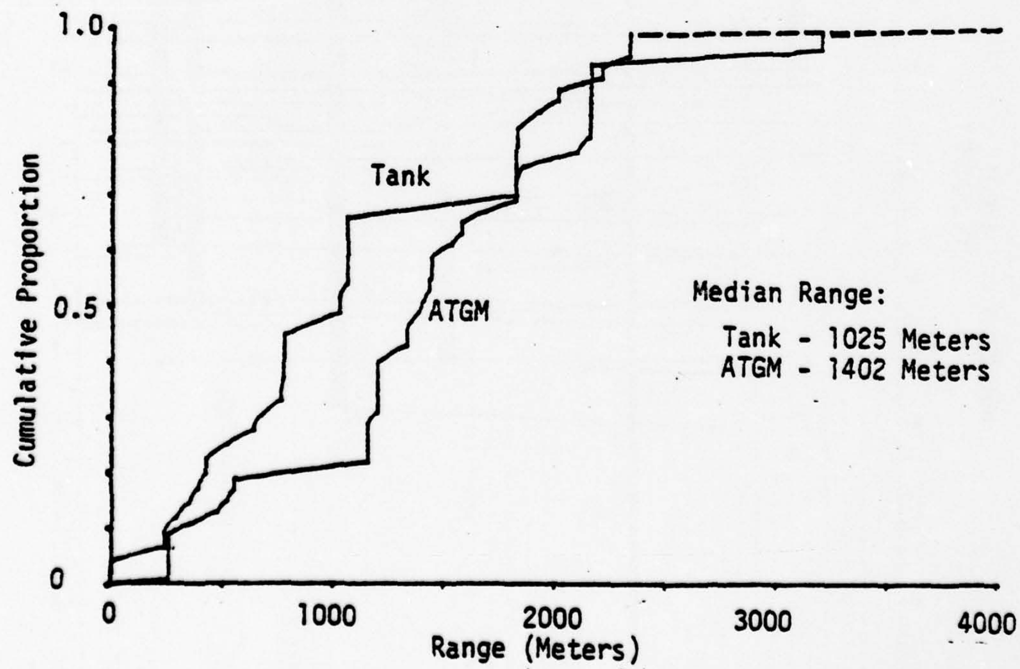


Figure 7. Cumulative proportion of attacker engagement ranges for each armor element on site A, both tactics combined[9]

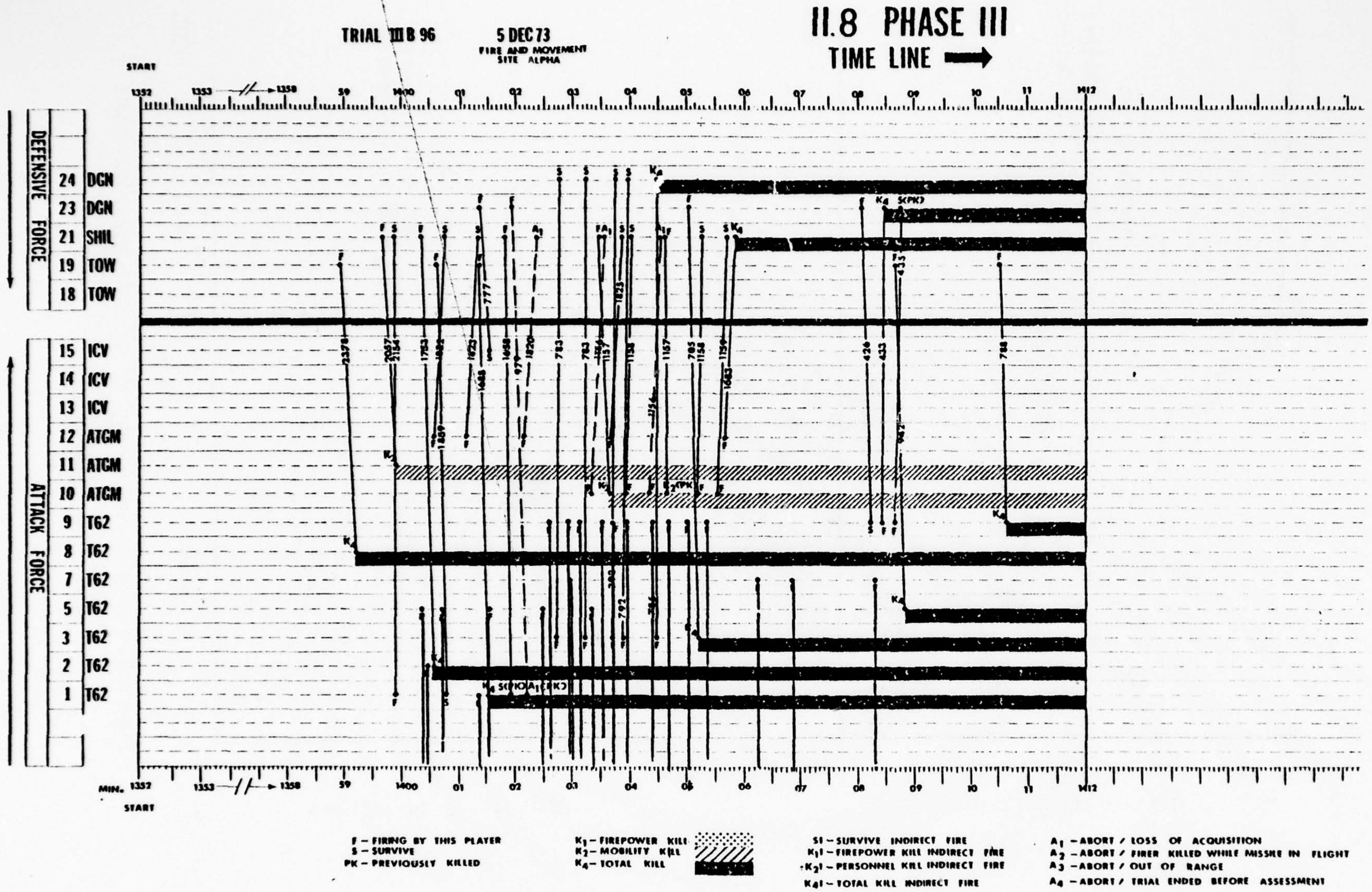


Figure 8. Trial 96 time line[10]

Table 10. Attacker firing rate and pairing rate [11]

Armor Element	Site A				Site B			
	Rapid Approach		Fire & Movement		Rapid Approach		Fire & Movement	
	Number Firings	Percent Pairings	Number Firings	Percent Pairings	Number Firings	Percent Pairings	Number Firings	Percent Pairings
Tank	0.9	18	5.4	18	1.8	39	4.3	16
ATGM	2.0	46	5.4	73	2.1	17	3.3	55
Average	1.2	31	5.4	31	1.9	32	4.0	24

Table 11. Final results of trial 96 12

Force Casualty Assessment

Force	Total Kills	Mobile Kill	Fire Kill	Totals
THREAT FORCE	6	2	0	8
Casualty Percentage				
THREAT FORCE	46	15	0	62
DEFENSIVE FORCE	3	0	0	3
Casualty Percentage				
DEFENSIVE FORCE	60	0	0	60

Initial Force Strengths

Threat 7-3-3

Defense 2-1-2

Type Casualty Assessment

Firers	Total Fires	Percent Paired	Target	Total Pairing	Total Kills	Mobile Kills	Fire Kill
TANK	30	27	TOW	0	0	0	0
			SHILL	1	0	0	0
			DRAGON	7	2	0	0
ATGM	10	100	TOW	0	0	0	0
			SHILL	10	1	0	0
			DRAGON	0	0	0	0
TOW	5	100	TANK	5	4	0	0
			ATGM	0	0	0	0
			ICV	0	0	0	0
SHILL	5	100	TANK	2	1	0	0
			ATGM	3	0	2	0
			ICV	0	0	0	0
DRAG	4	100	TANK	3	1	0	0
			ATGM	0	0	0	0
			ICV	1	0	0	0
Grand Total	40 / 14	45 / 100	Threat / Def	18 / 14	3 / 6	0 / 2	0 / 0

Table 12. Engagement data [13]

96	5	5		140022	-0	9		
96	2	5		140028	-0	9		
96	5	5		140045	-0	9		
96	2	5		140123	-0	9		
96	5	5		140135	-0	9		
96	5	5		140230	-0	9		
96	9	5		140235	-0	9		
96	9	5		140258	-0	9		
96	7	5		140300	-0	9		
96	9	5		140310	-0	9		
96	7	5		140322	-0	9		
96	9	5		140332	-0	9		
96	9	5		140345	-0	9		
96	9	5		140357	-0	9		
96	9	5		140425	-0	9		
96	9	5		140440	-0	9		
96	9	5		140501	-0	9		
96	9	5		140523	-0	*		
96	7	5		140615	-0	*		
96	7	5		140652	-0	*		
96	7	5		140819	-0	*		
96	19	1	6	135852	4	4	2378	11
96	19	1	1	135924	72	0	1859	8
96	21	2	11	135939	2	2	2057	10
96	1	5	21	135951	-1	0	2154	2
96	21	2	2	140015	3	4	1753	9
96	12	6	21	140025	6	0	1822	12
96	19	1	1	140051	28	4	1688	8
96	23	3	15	140055	24	0	777	10
96	12	6	21	140104	4	0	1823	12
96	21	2	1	140146	1	3	1658	9
96	23	3	1	140147	7	5	979	12
96	12	6	21	140156	7	5	1820	15
96	3	5	24	140234	5	0	783	1
96	3	5	24	140:11	-1	0	783	1
96	10	6	21	140:13	5	5	1156	15
96	12	6	21	140:35	3	0	1825	12
96	3	5	24	140:42	-1	0	792	1
96	10	6	21	140:43	8	0	1156	6
96	3	5	24	140356	-1	0	792	1
96	10	6	21	140407	12	5	1156	13
96	3	5	24	140424	-1	4	785	1
96	21	2	10	140427	6	3	1157	6
96	23	3	3	140458	2	4	705	9
96	10	6	21	140502	3	0	1158	8
96	10	6	21	140528	3	0	1159	6
96	12	6	21	14:532	3	4	1683	11
96	23	3	9	140802	1	0	426	6
96	9	5	23	140806	13	4	433	1
96	19	1	5	1·0826	15	4	942	4
96	9	5	23	1·0837	-1	3	435	1
96	19	1	9	140859	91	4	788	4
96	21	2	10	140320	8	2	1157	6

Column	Data Element
1	Trial number
2	Firer number
3	Ammo type
4	Target number (a blank indicates an unpaired firing - UF)
5	Detection time
6	Firing time (a-o indicates UF)
7	Casualty assessed (see figure 8)
8	Range
9	Time of flight

Additional questions arise as to the tactical formations used by the forces, the use of terrain, the specific objectives, and, of course, the degree to which the execution of the trial followed either the commander's plan or, in fact, the experimental design. For example, the definition "rapid approach" (RA) tactic can be well differentiated from "fire and movement" (FM) tactic by its speed and lack of maneuver. However, in the actual conduct of the experimental battles, some FM trials appeared to be executed faster than RA trials, just the opposite of what would be expected. Such evidence leads to the conclusion that further investigation of individual trials is necessary, a' posteriori, to insure that trial results can indeed be lumped together for the purpose of providing input to computer models. Indeed, the efficacy of averaging the results of trials for any reason without close examination of the data is subject to question.

Post-Trial Analysis Methodology (Trial Reconstruction)

A nine-step methodology for a' posteriori field experiment analysis is presented below. Note that step 1 and 4 are not applicable to the analysis of field experiments not yet conducted. Therefore, post-experiment analysis is the more general case. Subsequent paragraphs demonstrate the application of the methodology to phase III of the TETAM experiment.

Step 1 - Examine data available from published sources.

Step 2 - Compare data to model input requirements or event lists such as shown in tables 9 and 13. If data are available, skip to step 8.

Step 3 - Examine table 8 for additional sources of data.

Step 4 - Locate additional data. If insufficient state data are available to reconstruct locations of players for events of interest, skip to step 9.

Step 5 - Transform state data, and qualitative data if available, to standard format (data schema) described in chapter 2 and table 9.

Step 6 - Select appropriate transfer functions to plot results of trial; e.g., time-phased locations of movement detection and firing events.

Step 7 - Develop appropriate tactical planning documents from available data as required (e.g., OPORD).

Step 8 - Estimate model inputs from data documentation developed in steps 4 through 7. Run model.

Step 9 - Document results for future use.

Example - TETAM Trial 96

An illustration of the execution of the nine-step process described in the preceding paragraph is given below. The sources of the additional data that were obtained for trial 96 are given in the text and the referenced annexes to appendix A.

Step 1 - Data Available from Published Sources

CDEC initially published the results of phase III of TETAM in two volumes. Volume VIII contained the final report and volume IX was the data package. The general nature of the published data was illustrated at the beginning of this chapter. Other analyses of the data were conducted [14,15] but did little to detail what occurred in the individual trials.

Step 2 - Compare Data to Model Input Requirements

Typical inputs to DYNTACS have been shown in table 13. A comparison of the requirements for the generalized ATM engagement process

Table 13. Tactical scenario data - tactical situation at battle outset

Block Name	Description of Input Data Required	Data Application within DYNTACS
EDIR	Current Heading. Each *element's* initial direction of movement is specified at battle outset. Headings for moving elements are updated during execution.	Each *element's* current heading establishes the center of its sector of fire. The current heading of each *maneuver unit leader* is also used to compute each subordinate element's *principal observation direction*, an important variable in determining detection probabilities. The input value of EDIR is used as the *principal observation direction* for defenders.
LAMMO	Initial Ammunition Supply. Specifies the on-vehicle (or on-individual) basic load by round type for each *element* at battle outset.	The model keeps track of ammunition expenditures for each *element* by round type. When an *element* expends all of its ammunition, it simply stops firing. *Elements* make no effort to conserve ammunition as supplies are depleted.
DIRMU	Desired Movement Direction. The initial *desired movement direction* for each maneuver unit.	Values are only used at battle outset and only if the model user allows the model to specify initial locations for elements other than maneuver unit leaders.
LDPC	Desired Position Flag. Specifies whether each *element* is stationary or moving at battle outset.	This is one of the flags used throughout the simulation for coordinating movement and direct fires. It has no particular model implications.

(table 9) yielded the results shown in table 14. Since little of the data required by tables 9 and 13 were published, the methodology proceeds to step 3.

Step 3 - Identify Additional Sources of Data

Table 8 was used as a checklist for the identification of additional sources of data. The availability of the data that were found are shown in table 15. Three controllers were interviewed and the results of the interview are discussed at step 7.

Step 4 - Locate Additional Data

This is probably the most important step in the methodology. The success attainable may often be directly proportional to the time that has elapsed since the experiment was conducted and to the diligence of the investigator. In reconstructing the TETAM trials, the most significant find was a set of punched cards that contained the locations of each attacker for each minute of each trial (see table 16. The transformation of figure 2 produced the second column from the right and a similar transformation produced the last column on the right.) The card deck also contained the initial position of each defender. The use to which these data were put will be discussed at step 6 below. The locations of artillery simulators were also discovered, but the times at which these simulators were fired were not found, a shortcoming that minimized the usefulness of the data.

Step 5 - Transform Data to Standard Format

The state data that were found and later used in this investigation were in two separate formats, as shown in tables 12 and 16. The data were then transformed into the standard schema through a linear interpolation resulting in the reconstruction of three types of

Table 14. Quantitative data available to describe ATM engagement events/activities in phase III, TETAM

	Position Selection & Preparation	Target Detection	Target Acquisition	Target Identification	Range Estimation	Decision to Engage	Msl Flight	Missile Tracking	Impact Damage Assessment	Reload	Evasive Action
1. Participant(s)		X		X			X	X			
2. x,y location, time		X					X	X	X	X	
3. Principal direction of fire											
4. Left and right limits of sector											
5. Exposed area of weapon/vehicle											
6. Degree of camouflage											
7. Killing zone location									X		
8. Crew training, proficiency											
9. Cue (smoke, noise movement, firing)											
10. Uncued (search pattern, sector)											
11. Light levels											
12. Vision aids (power, field of view)		X									
13. Estimated range						X					
14. Target priority, engagement rules						X					
15. Basic load, remainging load											
16. Time of fire, impact							X				
17. Missile reliability, effectiveness							X		X		X
18. Estimated/actual results						X			X		
19. Round type											

Table 15. Qualitative data available to describe TETAM events/activities in Phase III, TETAM

Generalized Information Available / Operational Training and Execution Tools	Participants & Capabilities (Who)	Action to be Taken (What)	Location of Kill Zones, Weapons, & Other Participants (Where)	Time of Event (When)	Fire Commands, Target Priorities, Signals (How)	Training	Friendly and Enemy Situation & Tactics (Why)	When Used	Recording Media
Field Manuals, ARTEPs, SQT		1				1			N/A
Analysis of Area of Operation									Document (standard format)
ARTEP, SQT Scores									Document
Estimate of Situation (Reconnaissance)			2				2		Voice Tape, Document (Std fmt)
Operations Order	2	2	2	2	1,2		2		Document
Fragmentary Order									Voice Tape
Fire Plan (Artillery, TACAIR) Range Cards	1	1	1	1					Document (standard format)
Weather Data							2		Document
Maintenance Records									Document
Debriefing				1		1	1		Voice Tape, Document

Notes:

1. *Found in unpublished form*
2. Reconstructed from interviews and/or analysis

Table 16. Location data for trial 96

TRIAL	WPN	TIME	XCOORD	YCOORD	SPD (M/S)	(MILES/HR)
96	1	1353	53048.	80855.	5.3	11.9
96	1	1354	53325.	80696.	4.2	9.[illegible]
96	1	1355	53514.	80526.	4.7	10.5
96	1	1356	53645.	80278.	6.8	15.2
96	1	1357	53571.	79878.	2.8	6.3
96	1	1358	53592.	79709.	5.5	12.3
96	1	1359	53740.	79415.	6.1	13.7
96	1	1400	53966.	79126.	6.7	15.0
96	1	1401	54247.	78837.	1.5	3.3
96	1	1402	54287.	78758.	.4	.9
96	1	1403	54276.	78778.	.0	.0
96	1	1412	54280.	78779.		
96	2	1352	53018.	80875.	3.7	8.4
96	2	1353	53087.	80661.	5.0	11.2
96	2	1354	53172.	80374.	9.2	20.6
96	2	1355	53413.	79877.	4.0	[illegible]
96	2	1356	53539.	79676.	2.1	4.6
96	2	1357	53653.	79628.	.4	.8
96	2	1358	53672.	79616.	6.1	13.7
96	2	1359	53822.	79282.	7.3	16.3
96	2	1400	54127.	78969.	3.6	[illegible]
96	2	1401	54245.	78788.	.0	.0
96	2	1412	54247.	78788.		
96	3	1352	53067.	80902.	2.2	4.9
96	3	1353	53151.	80802.	5.5	12.3
96	3	1354	53435.	80632.	5.2	11.7
96	3	1355	53584.	80357.	4.4	9.9
96	3	1356	53643.	80099.	4.3	9.7
96	3	1357	53651.	79839.	.2	.5
96	3	1358	53642.	79828.	4.2	9.3
96	3	1359	53851.	79692.	4.7	10.5
96	3	1400	54067.	79512.	8.4	18.9
96	3	1401	54264.	79045.	7.0	15.6
96	3	1402	54555.	78745.	1.4	3.2
96	3	1403	54602.	78673.	.0	.0
96	3	1412	54596.	78679.		
96	5	1352	53008.	80844.	4.8	10.7
96	5	1353	53072.	80563.	5.8	13.0
96	5	1354	53242.	80258.	8.6	19.2
96	5	1355	53412.	79771.	3.5	7.8
96	5	1356	53441.	79564.	3.3	7.3
96	5	1357	53492.	79374.	5.5	12.3
96	5	1358	53714.	79129.	6.1	13.6
96	5	1359	54003.	78906.	2.9	6.4
96	5	1400	54113.	78774.	.7	1.5
96	5	1401	54144.	78748.	2.0	4.5
96	5	1402	54233.	78668.	.5	1.0
96	5	1403	54249.	78645.	1.8	4.0
96	5	1404	54326.	78570.	1.1	2.5
96	5	1405	54388.	78548.	.3	.7
96	5	1406	54369.	78554.	3.4	7.7
96	5	1409	54894.	78231.	.0	.1
96	5	1412	54889.	78224.		
96	7	1352	53064.	80860.	2.7	6.0

Table 16. Location data for trial 96 (continued)

TRIAL	WPN	TIME	XCOORD	YCOORD	SPD (M/S)	(MILES/HR)
96	7	1353	53189.	80760.	6.3	14.0
96	7	1354	53498.	80547.	5.4	12.1
96	7	1355	53664.	80269.	7.2	16.0
96	7	1356	53613.	79842.	1.1	2.4
96	7	1357	53678.	79839.	.1	.2
96	7	1358	53682.	79835.	4.6	10.3
96	7	1359	53896.	79662.	7.3	16.3
96	7	1400	54152.	79306.	8.2	18.4
96	7	1401	54512.	78967.	2.1	4.7
96	7	1402	54576.	78859.	5.7	12.7
96	7	1403	54809.	78612.	1.1	2.5
96	7	1404	54835.	78675.	1.7	3.7
96	7	1405	54929.	78642.	2.5	5.6
96	7	1406	55062.	78573.	1.3	2.2
96	7	1407	55127.	78531.	3.2	7.3
96	7	1408	55271.	78400.	4.2	9.3
96	7	1409	55426.	78205.	1.4	3.2
96	7	1410	55504.	78171.	.0	.1
96	7	1412	55507.	78173.		
96	8	1353	53053.	80719.	4.4	9.9
96	8	1354	53127.	80465.	7.5	16.7
96	8	1355	53338.	80070.	5.9	13.1
96	8	1356	53473.	79746.	3.5	7.9
96	8	1357	53618.	79590.	.8	1.7
96	8	1358	53663.	79594.	4.9	11.0
96	8	1359	53775.	79322.	4.8	10.7
96	8	1400	53956.	79098.	.2	.5
96	8	1401	53945.	79106.	.0	.0
96	8	1412	53951.	79101.		
96	9	1352	53050.	80818.	4.7	10.5
96	9	1353	53094.	80540.	6.6	14.7
96	9	1354	53279.	80191.	7.8	17.5
96	9	1355	53440.	79751.	3.5	7.9
96	9	1356	53450.	79539.	3.9	8.7
96	9	1357	53515.	79316.	5.6	12.6
96	9	1358	53792.	79122.	6.5	14.6
96	9	1359	54074.	78852.	3.0	6.8
96	9	1400	54193.	78714.	3.8	8.5
96	9	1401	54352.	78551.	1.3	2.9
96	9	1402	54424.	78521.	.1	.3
96	9	1403	54420.	78514.	.0	.1
96	9	1404	54421.	78512.	.0	.1
96	9	1405	54419.	78512.	2.3	5.0
96	9	1406	54527.	78431.	2.0	4.4
96	9	1407	54636.	78384.	.4	.8
96	9	1408	54658.	78387.	1.4	3.2
96	9	1409	54734.	78347.	3.2	7.3
96	9	1410	54889.	78229.	1.5	3.4
96	9	1411	54980.	78221.	.0	.1
96	9	1412	54960.	78223.		
96	10	1352	53043.	80897.	2.1	4.7
96	10	1353	53122.	80800.	5.5	12.2
96	10	1354	53405.	80636.	4.6	10.2
96	10	1355	53559.	80410.	5.0	11.3

Table 16. Location data for trial 96 (continued)

TRIAL	WPN	TIME	XCOORD	YCOORD	SPD(M/S)	(MILES/HR)
96	10	1356	53643.	80119.	4.8	10.8
96	10	1357	53630.	79830.	.1	.1
96	10	1358	53627.	79830.	4.2	9.3
96	10	1359	53847.	79713.	4.8	10.8
96	10	1400	54066.	79525.	7.1	15.8
96	10	1401	54290.	79164.	8.3	18.5
96	10	1402	54670.	78843.	4.4	9.8
96	10	1403	54797.	78612.	.0	.1
96	10	1404	54799.	78614.	.0	.0
96	10	1412	54804.	78619.		
96	11	1352	53016.	80897.	1.7	3.8
96	11	1353	53023.	80795.	4.4	9.8
96	11	1354	53095.	80542.	6.0	13.3
96	11	1355	53263.	80227.	7.9	17.7
96	11	1356	53423.	79780.	3.7	8.4
96	11	1357	53606.	79650.	.3	.6
96	11	1358	53619.	79641.	5.3	11.8
96	11	1359	53749.	79351.	8.1	18.2
96	11	1400	54007.	78936.	.2	.5
96	11	1401	54021.	78933.	.0	.0
96	11	1412	54018.	78937.		
96	12	1352	52985.	80870.	1.8	4.0
96	12	1353	53026.	80770.	5.0	11.1
96	12	1354	53107.	80483.	6.8	15.3
96	12	1355	53292.	80116.	6.6	14.8
96	12	1356	53428.	79742.	5.4	12.1
96	12	1357	53482.	79423.	5.3	11.9
96	12	1358	53658.	79158.	6.9	15.3
96	12	1359	53987.	78911.	2.8	6.3
96	12	1400	54092.	78780.	.4	.9
96	12	1401	54114.	78789.	.2	.5
96	12	1402	54121.	78800.	.8	1.8
96	12	1405	54216.	78686.	.1	.2
96	12	1406	54218.	78692.	3.3	7.4
96	12	1407	54356.	78548.	.4	.9
96	12	1408	54376.	78536.	1.0	2.3
96	12	1409	54406.	78482.	.3	.7
96	12	1410	54410.	78464.	.8	1.7
96	12	1411	54446.	78494.	1.2	2.6
96	12	1412	54504.	78447.		
96	13	1352	52994.	80898.	2.0	4.5
96	13	1353	53039.	80785.	4.8	10.8
96	13	1354	53109.	80503.	6.7	15.1
96	13	1356	53418.	79757.	5.4	12.2
96	13	1357	53470.	79435.	5.1	11.3
96	13	1358	53634.	79179.	7.1	15.9
96	13	1359	53976.	78924.	3.0	6.6
96	13	1400	54076.	78771.	.4	.8
96	13	1401	54096.	78778.	.1	.3
96	13	1402	54104.	78777.	1.9	4.4
96	13	1403	54176.	78685.	.1	.3
96	13	1404	54177.	78693.	3.8	8.4
96	13	1405	54348.	78545.	.1	.3
96	13	1406	54345.	78552.	4.0	8.8

Table 16. Location data for trial 96 (concluded)

TRIAL	WPN	TIME	XCOORD	YCOORD	SPD(M/S)	(MILES/HR)
96	13	1407	54480.	78357.	.8	1.7
96	13	1408	54525.	78366.	6.4	14.4
96	13	1409	54878.	78524.	6.1	13.7
96	13	1410	55166.	78296.	1.9	4.3
96	13	1411	55279.	78271.	.8	1.7
96	13	1412	55233.	78275.		
96	14	1352	53071.	80911.	1.6	3.5
96	14	1353	53107.	80823.	5.7	12.8
96	14	1354	53401.	80645.	3.4	7.6
96	14	1355	53527.	80485.	5.5	12.2
96	14	1356	53664.	80188.	6.0	13.5
96	14	1357	53613.	79830.	.1	.3
96	14	1358	53621.	79830.	4.0	9.0
96	14	1359	53838.	79725.	4.8	10.6
96	14	1400	54053.	79537.	6.2	14.0
96	14	1401	54251.	79219.	7.0	15.7
96	14	1402	54590.	78967.	4.1	9.2
96	14	1403	54731.	78764.	1.9	4.3
96	14	1404	54743.	78650.	1.6	3.5
96	14	1405	54838.	78648.	2.8	6.3
96	14	1406	54998.	78591.	1.3	3.0
96	14	1407	55051.	78530.	3.4	7.6
96	14	1408	55227.	78425.	2.0	4.6
96	14	1409	55273.	78311.	.8	1.8
96	14	1410	55291.	78265.	.1	.2
96	14	1411	55295.	78263.	.8	1.8
96	14	1412	55249.	78278.		
96	15	1352	53011.	80898.	1.6	3.6
96	15	1353	53038.	80804.	4.9	11.0
96	15	1354	53108.	80518.	6.3	14.2
96	15	1355	53281.	80180.	7.1	16.0
96	15	1356	53415.	79773.	3.5	7.9
96	15	1357	53588.	79649.	.4	.9
96	15	1358	53599.	79627.	5.1	11.3
96	15	1359	53747.	79362.	8.5	19.1
96	15	1400	54093.	78985.	6.0	13.4
96	15	1401	54319.	78704.	4.2	9.3
96	15	1402	54568.	78686.	.3	.7
96	15	1403	54585.	78679.	.0	.1
96	15	1404	54587.	78681.	.1	.2
96	15	1405	54588.	78676.	3.1	7.0
96	15	1406	54765.	78616.	3.2	7.1
96	15	1407	54940.	78544.	7.1	16.0
96	15	1408	55283.	78288.	0.0	0.0
96	15	1411	55283.	78288.	1.4	3.1
96	15	1412	55202.	78272.		
96	18	1412	55867.	77794.		
96	19	1412	55566.	77729.		
96	21	1412	55692.	77879.		
96	23	1412	55005.	78093.		
96	24	1412	54958.	77974.		

events: detection, firing and impact. These events are listed in table 17. (Not all the information in the input data vectors has been printed out due to space limitations on the page.) The "-0" in the target column indicates an unpaired firing.

Very little qualitative data were found that were applicable to an individual event. However, controller notes for the defending force were found (table 15) and these are incorporated in the defensive OPORD at step 7 below.

Step 6 - Plot Results of Trial

The location event data of table 16 are used to plot figure 9. The attacker firing data from table 17 are plotted in figure 10 and the defender firing data in figure 11. The latter two figures can be used as overlays to figure 9 making it possible to see the geometry of the battle. The straight lines in figures 10 and 11 are the paired firings, drawn from firer to target. The small crosses in figure 10 are unpaired attacker firings (i.e., the data collection equipment failed to determine who the target was. See reference 1 for a discussion of this phenomenon.). Figure 8 gives the identities of the players.

The figures were plotted using a Hewlett Packard 9830 mini-computer. A much larger plot was obtained from a Calcomp plotter to do the detailed analysis. Computer graphics equipment would be very helpful at this step in order to examine the time phasing of the vehicles.

Step 7 - Develop Tactical Planning Documents

This step initiates the truly subjective analysis of the data discovered and processed thus far. It is at this point that qualitative data such as debriefing forms and controller comments that refer to the experiment in general are applied. The information may often

Table 17. DETECTION AND ENGAGEMENT DATA, TRIAL 96 (INTERPOLATED FROM FIELD DATA) (continued next page)

FIRER	TGT	DETECTION DATA TIME	RANGE	FIRER POSN	TARGET POSN	FIRING DATA TIME	RANGE	FIRER POSN	IMPACT DATA TIME	RANGE	TARGET POSN	CASUALTY ASSESSED
19	6	135852	2432	5556677729	5376079353	135856	2378	5556677729	135907	2363	5379679295	K4(TUT)
19	1	135926	2340	5556677729	5383079299	140036	1859	5556677729	140044	1829	5417278914	SURVIVE
21	11	135939	2144	5569277879	5391679081	135941	2057	5569277879	135951	2055	5396878998	K2(MK)
1	21	135951	2182	5393279169	5569277879	135950	2154	5392679174	135952	2188	5569277879	SURVIVE
21	2	140015	1857	5569277879	5415678923	140018	1753	5569277879	140027	1617	5418076887	K4(TUT)
5	-0	140022	0	5412478764	0 0	140022	-0	5412478764	140022	0	0 0	UNPFRG
12	21	140025	1829	5410178783	5569277879	140031	1822	5410378784	140043	1628	5569277879	SURVIVE
2	-0	140028	0	5418278884	0 0	140028	-0	5418278884	140028	0	0 0	UNPFRG
5	-0	140045	0	5413678754	0 0	140045	-0	5413678754	140045	0	0 0	UNPFRG
13	11	140051	1783	5556677729	5420478880	140119	1688	5556677729	140127	1686	5426478801	K4(TUT)
23	15	140055	948	5500578093	5430078727	140119	777	5500578093	140129	826	5443978695	SURVIVE
12	21	140104	1821	5411478789	5569277879	140108	1823	5411478790	140120	1822	5569277879	SURVIVE
2	-0	140123	0	5424578788	0 0	140123	-0	5424578788	140123	0	0 0	UNPFRG
5	-0	140135	0	5419578701	0 0	140135	-0	5419578701	140135	0	0 0	UNPFRG
21	1	140146	1675	5569277879	5427778776	140147	1658	5569277879	140155	1663	5428378764	PREV KL
23	1	140147	996	5500578093	5427878775	140154	979	5500578093	140206	980	5428578759	A1(L/A)
12	21	140158	1821	5412078799	5569277879	140205	1820	5412378796	140220	1617	5569277879	A1(L/A)
5	-0	140230	0	5424178656	0 0	140230	-0	5424178656	140230	0	0 0	UNPFRG
3	24	140234	921	5458178704	5495877974	140242	783	5458778694	140243	609	5495877974	SURVIVE
9	-0	140235	0	5442178516	0 0	140235	-0	5442178516	140235	0	0 0	UNPFRG
9	-0	140258	0	5442078514	0 0	140258	-0	5442078514	140258	0	0 0	UNPFRG
7	-0	140300	0	5480978612	0 0	140300	-0	5480978612	140300	0	0 0	UNPFRG
9	-0	140310	0	5442078513	0 0	140310	-0	5442078513	140310	0	0 0	UNPFRG
3	24	140311	784	5460178673	5495877974	140310	783	5460178673	140311	784	5495877974	SURVIVE
10	21	140313	1156	5479778612	5569277879	140316	1156	5479778612	140331	1156	5569277879	A1(L/A)
21	10	140320	1156	5569277879	5479778612	140328	1157	5569277879	140334	1156	5479878613	K2(MK)
7	-0	140322	0	5481878635	0 0	140322	-0	5481878635	140322	0	0 0	UNPFRG
9	-0	140332	0	5442078512	0 0	140332	-0	5442078512	140332	0	0 0	UNPFRG
12	21	140335	1747	5417178739	5569277879	140338	1825	5417278737	140350	1745	5569277879	SURVIVE
3	24	140342	784	5460178673	5495877974	140341	792	5460178673	140342	784	5495877974	SURVIVE
10	21	140343	1156	5479878613	5569277879	140351	1158	5479878613	140359	1156	5569277879	SURVIVE
9	-0	140345	0	5442078512	0 0	140345	-0.	5442078512	140345	0	0 0	UNPFRG
3	24	140356	784	5460178673	5495877974	140355	792	5460178673	140356	784	5495677974	SURVIVE
9	-0	140357	0	5442078512	0 0	140357	-0	5442078512	140357	0	0 0	UNPFRG
10	21	140407	1156	5479978614	5569277879	140419	1156	5479978614	140432	1156	5569277879	A1(L/A)

Table 17. DETECTION AND ENGAGEMENT DATA, TRIAL 96
(INTERPOLATED FROM FIELD DATA) (concluded)

FIRER	TGT	DETECTION DATA				FIRING DATA			IMPACT DATA			CASUALTY
		TIME	RANGE	FIRER POSN	TARGET POSN	TIME	RANGE	FIRER POSN	TIME	RANGE	TARGET POSN	ASSESSED
3	24	140424	784	5460178673	5495877974	140423	785	5460178673	140424	784	5495877974	K4(TOT)
9	-0	140425	0	5442078512	0 0	140425	-0	5442078512	140425	0	0 0	UNPFRG
21	10	140427	1156	5569277879	5479978614	140433	1157	5569277879	140439	1156	5479978614	PREV KL
9	-0	140440	0	5441978512	0 0	140440	-0	5441978512	140440	0	0 0	UNPFRG
23	3	140458	708	5500578093	5460078674	140500	705	5500578093	140509	708	5460078674	K4(TOT)
9	-0	140501	0	5442078510	0 0	140501	-0	5442078510	140501	0	0 0	UNPFRG
10	21	140502	1156	5479978614	5569277879	140505	1158	5479978614	140513	1156	5569277879	SURVIVE
7	-0	140523	0	5497978615	0 0	140523	-0	5497978615	140523	0	0 0	UNPFRG
10	21	140528	1156	5479978614	5569277879	140531	1159	5479978614	140539	1156	5569277879	SURVIVE
12	21	140532	1682	5421778689	5569277879	140535	1683	5421778689	140546	1682	5569277879	K4(TOT)
7	-0	140615	0	5507878562	0 0	140615	-0	5507878562	140615	0	0 0	UNPFRG
7	-0	140652	0	5511878536	0 0	140652	-0	5511878536	140652	0	0 0	UNPFRG
23	9	140802	451	5500578093	5466078385	140803	426	5500578093	140809	442	5466978381	SURVIVE
9	23	140806	446	5466578383	5500578093	140824	433	5468878371	140825	421	5500578093	K4(TOT)
7	-0	140819	0	5532078338	0 0	140819	-0	5532078338	140819	0	0 0	UNPFRG
19	5	140826	955	5556677729	5479478292	140841	942	5556677729	140845	889	5485078257	K4(TOT)
9	23	140837	403	5470478362	5500578093	140836	435	5470378363	140837	405	5500578093	PREV KL
19	9	140859	1038	5556677729	5473278347	141030	788	5556677729	141034	798	5494078224	K4(TOT)

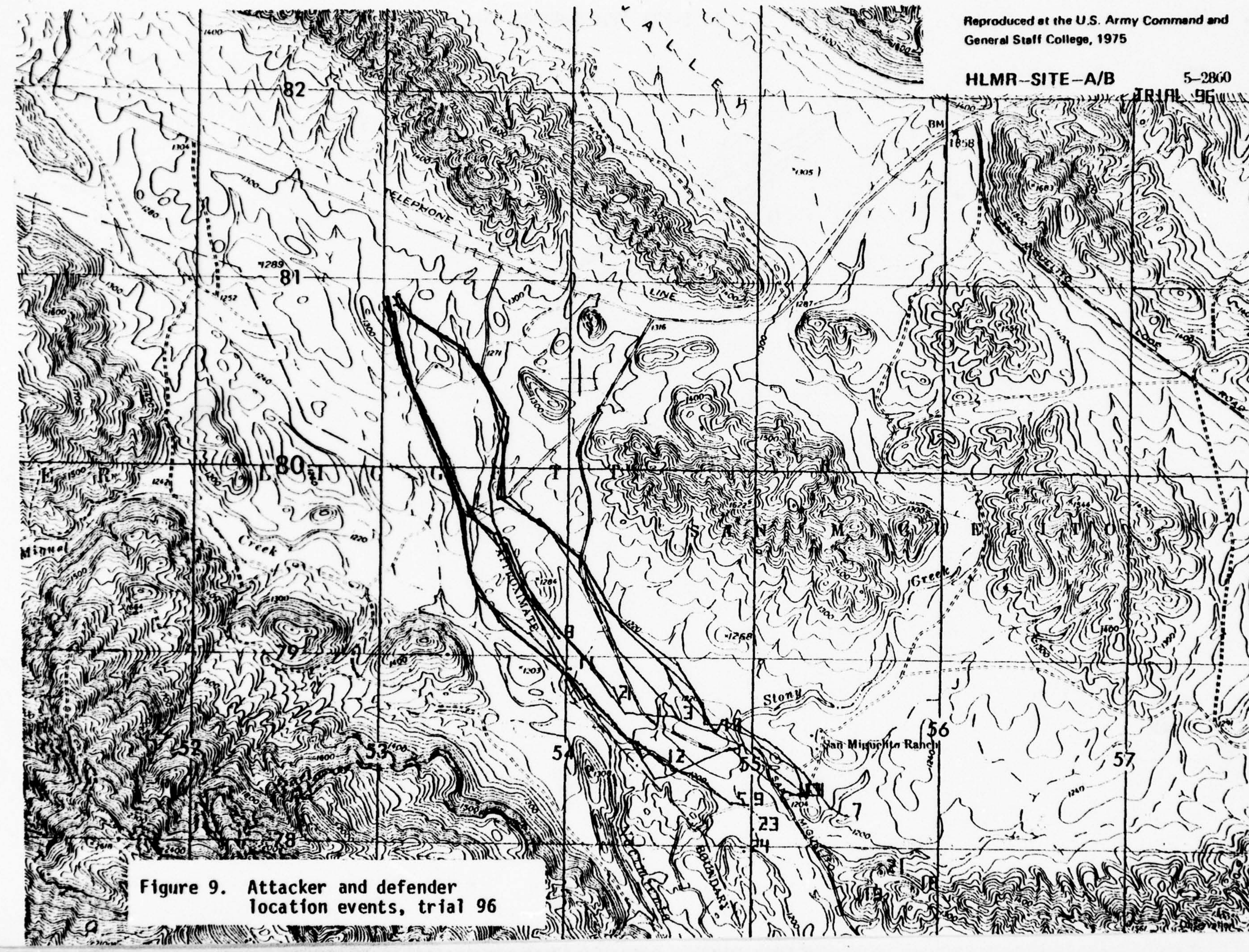


Figure 9. Attacker and defender location events, trial 96

Figure 10. Attacker engagements, trial 96

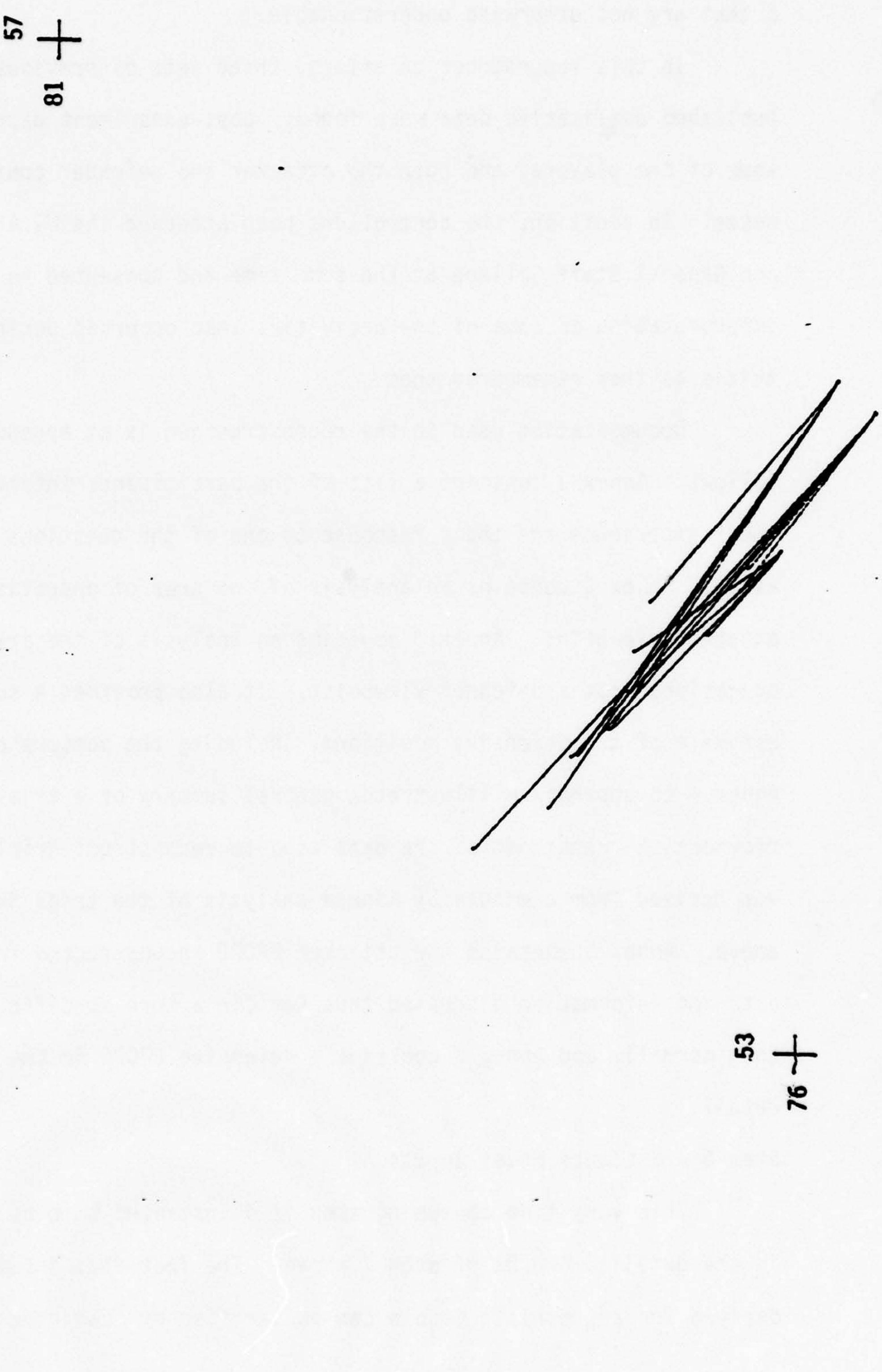


Figure 11. Defender engagements, trial 96

provide insights into actions observed in the plots developed in step 6 that are not otherwise understandable.

In this reconstruction effort, three sets of previously unpublished qualitative data were found; post-experiment debriefings of some of the players, and both the attacker and defender controller notes. In addition, the controllers both attended the US Army Command and General Staff College at the same time and consented to provide interpretation of some of the activities that occurred during the trials as they remembered them.

Documentation used in the reconstruction is at appendix A as follows. Annex 1 contains a list of the participants interviewed, their experience and their response to one of the questions they were asked. Annex 2 contains an analysis of the area of operations from the attacker viewpoint. Annex 3 contains an analysis of the area of operations from a defender viewpoint. It also provides a subjective estimate of the defensive positions, including the sectors of fire. Annex 4 to appendix A illustrates general summary of a trial and provides the remainder of the data used to reconstruct trial 96. It was derived from a minute by minute analysis of the trial in step 6 above. Annex 5 contains the attacker OPORD reconstructed from all the data and information discussed thus far (in a more specific format than normal), and annex 6 contains a defensive OPORD in the same detail.

Step 8 - Estimate Model Inputs

This very time consuming step is illustrated here by the data in the detailed OPORDs of step 7 above. The fact that inputs can be derived for appropriate models can be verified by examining table 13, reference 16, and documentation of other models.

Step 9 - Document Results for Future Use.

Any data not covered in the previous steps can be documented here.

Summary

This chapter was devoted to a discussion of a method for providing model inputs from the field experiment data, even though such data may not have been initially sufficient for model input purposes. This was accomplished by reconstructing trial 96 of the TETAM experiment. The methodology relies on the concepts of chapters 2 and the data sources of chapter 3. Not only are the latter sources useful from an overall data analysis point of view, but they are also used in appendix A to document the reconstructed trial for model input purposes.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The discussions in the preceding chapters have illustrated the different types of data that describe combat processes. A schema for handling the data was proposed, a useful way of defining the types of data was discussed, and the different uses to which they can be put was demonstrated. Several sources of data required to define the antitank missile engagement process were identified, and a practical application was demonstrated. This has led to the following conclusions.

Conclusions

1. An efficient schema for collecting data from field experiments is feasible. The schema is useful both for the analysis of experimental results and for the interface of those results with computerized combat models for sensitivity analysis, provided that sufficient state data are collected during the experiment.

2. Standard US Army planning tools such as Analyses of Area of Operations and Operations Orders, as well as training analysis tools such as ARTEPS, field manuals and SQTs are useful sources of information when the question of field experiment data collection arises.

3. Effort should be directed to identifying the state and qualitative data underlying combat process of interest in field experimentation so that provisions can be made for efficient and

timely data collection. This is not an easy task, but the rewards should be worth the effort.

Recommendations

The data schema has been demonstrated to lend itself to the collection of data through automatic data processing means. However, it should not be limited to experiments where sufficient ADP equipment is available. Rather, the schema should be used to identify the state data required to describe an event and every available means should be examined to collect the data. If the right data are collected by other than sophisticated ADP equipment, the only problem likely to arise is one of data accuracy. For example, assume that location data are collected by throwing readily identifiable blocks off the back of tanks every 10 minutes, and then surveyed in by artillery survey teams. All engagements that occur during that period will have relatively inaccurate ranges associated with them, yet the general geometry of battlefield will be known - a fact that will permit sensitivity analyses to be run using computerized combat models. This leads to the recommendation that the data schema developed herein be used not only as a means for recording data under conditions where sophisticated ADP equipment are available, but also for exercises where they are not, such as field training exercises, command-post exercises, and in field experiments as backup data for checking the ADP-calculated results.

APPENDIX A

APPENDIX A

SUPPLEMENTARY DATA

Introduction

This appendix contains documentation of several types of data that, because of their sheer size, were not included in chapter 4. These data are important to an understanding of the discussions of both chapters 3 and 4 and are vital to the reconstruction of trial 96. Model inputs for DYNTACS can be derived from the reconstructed OPORDs of inclosures 4 and 5.

Organization

Annex 1 contains comments on one of several questions asked of trial participants after the experiment. These comments were not published in the TETAM final report, although they were considered in the military judgment section of the final report.

Annex 2 contains an analysis of the area of operation of the TETAM experiment. It is taken from an unpublished special study project done by a controller of the TETAM experiment.[17] While assigned to USACDEC, he was responsible for debriefing the attacking force after each trial. He also observed each of the trials while they were being conducted.

The analysis is primarily concerned with the characteristics of the terrain known as site A (figures 12 and 15). It describes the characteristics of the area in sufficient detail to allow judgments on the part of modelers concerning the attacker's use of the terrain. It locates and describes areas of the battlefield containing covered and/or concealed routes, killing zones, untrafficable and off limits areas, etc., which may have had significant effects on trial results.

The analysis is written in the past tense in a somewhat modified form of the standard analysis.

Annex 3 discusses the defender positions used in the various trials on site A. It was also developed as a special study project by the TETAM defensive force controller. [18]

The information gained from the quantitative data of chapter 4, combined with the player comments of annex 1, Analysis of the AO of annex 2 and analysis of the defender positions of annex 3 are combined into a trial narrative in annex 4. These data are then combined into the two OPORDs presented in annex 5 (Attacking Force) and annex 6 (Defending Force).

Annex 1 to Appendix A

PLAYER COMMENTS

1. INTRODUCTION. Various players from the groups who participated in the TETAM Phase III trials were debriefed prior to their departure for their home station. The questions which they were asked fell into several categories, such as:

a. Training; including the training the players had received on a particular weapon system prior to arriving at Hunter Liggett Military Reservation (HLMR) the effectiveness of the tactical and crew training received at HLMR, and the value of the experience gained by participating in the Phase III trials.

b. Tactics; including player perceptions as to which of their own tactics were most effective, which tactics were most effective against them, and any special problems which they encountered during the different subphases in which they participated.

c. Command and control; including player use of hand-off information, the effectiveness of platoon leader/company commander's operations orders and plans, and the effectiveness of the communications capabilities which were played.

d. Target detection and engagement information.

e. Miscellaneous topics concerning administration, billeting, and suggestions for improving the experiment.

2. PURPOSE. The purpose of this inclosure is to present the information obtained from the player-group debriefings. This information is useful when it is compared to the player trial participation charts at inclosure b to this Annex because it permits a subjective estimate of what was happening during a particular set of trials.

3. ORGANIZATION OF THIS INCLOSURE.

a. General. Paragraphs 4a and 4b, below, list personnel data for attacking forces from the 2d Armored Division and 1st Cavalry Division players, respectively. Paragraphs 4c and 4d list similar data for the defensive players from these divisions, respectively. Paragraphs 5 and 6 contain a list of the questions asked of the players listed in paragraph 4, and their individual or group response (as appropriate). The individual players (or groups) who were interviewed have been given letter designations (e.g., "(a)", "(b)", etc.) within each attacker or defender player group. These designations can be used to relate the response of attacker player "(a)" to a particular question in paragraph 5, to his experience, position or training as outlined in paragraph 4c. The questions presented in the following paragraphs were posed to the players after the completion of all their trials. The replies were outlined by data collectors and are rather cryptic so they have been edited somewhat, in the interest of clarity. The words or phrases which have been adited or interpreted are inclosed in parentheses.

b. Caveats. It is unlikely that all the players who participated in the experiment were interviewed, nor that all the players that were interviewed had participated in all the trials in which their respective player groups had participated. This is especially true of the DRAGON gunners, who were often "fillers" from the Experimentation Bridage stationed at Hunter Liggett, and were assigned to trials on a day-to-day basis. In addition, the identifies of all the individuals who participated in a particular trial are not available. As a result, the information presented in paragraph 5 is only generally useful and cannot be related to a particular trial. It can, however, be related to the sets of trials in which that group participated.

4. MILITARY TRAINING AND EXPERIENCE.

a. Attackers (Second Armored Division Player Group).

PLAYERS	POSITION	RANK	SPECIAL TRAINING	SCHOOLING	ARMOR EXPERIENCE	COMBAT EXPERIENCE
(1) Tank Cdrs & Gunners						
(a)	TC/Plt Ldr	1 LT	None	AOBC	4 mos	No
	Gunner	PFC	None	Armor AIT	14 mos	No
(b)	TC/Plt Ldr	2 LT	None	AOBC	7 mos	No
	Gunner	PFC	None	Armor AIT	17 mos	No
(c)	TC/Plt Ldr	2 LT	None	AOBC	7 mos	No
	Gunner	PFC	None	Armor AIT	*	*
(d)	TC/Plt Ldr	1 LT	None	AOBC	14+ mos	Yes
	Gunner	PFC	None	Armor AIT	*	*
(e)	TC	SGT	None	OJT	8 mos	*
	Gunner	PFC	None	*	15 mos	*
(f)	TC	SSG	Various MOS Schs	*	23 yrs	6½ yrs
	Gunner	PFC	None	Armor AIT	12 mos	No
(g)	TC	SGT	TC Sch	*	2½ yrs	No
	Gunner	PFC	None	Armor AIT	12 mos	*

* Data not available

PLAYERS	POSITION	RANK	SPECIAL TRAINING	SCHOOLING	ARMOR EXPERIENCE	COMBAT EXPERIENCE
(2) ATGM Gunners						
(h)	ATGM Gunner	SP4	TOW Sch**	*	*	*
	ATGM Gunner	SP4	None	*	*	*
	ATGM Gunner	PFC	None	*	*	*
(3) ICV Drivers						
(i)	ICV Driver/Cdr	SP4	None	Armor AIT	10 mos	No
b. Attackers (1st Cavalry Division).						
(4) Tank Commander and Gunners						
(j)	CO/TC	CPT	Aviator	AOAC	6 mos (as CO)	Yes
	Gunner	PFC	None	Armor AIT	10 mos	
(k)	TC	SGT	TC School	Armor AIT	2 yrs	No
	Gunner	SP5	None	NCO School	3 yrs	Yes
	TC	SGT	None	Armor AIT	3 yrs (as TC)	No
	Gunner	PFC	None	*	4 mos	No
	Gunner	PFC	None	Armor AIT	1 yr	*
	Gunner	SP5	None	Armor AIT	15 mos	*
(l)	TC	SGT	TC School	*	4 yrs (as TC)	No
	Gunner	PFC	None	Armor AIT	1 yr	*
(m)	TC	SGT	None	OJT	2 yrs	No
	Gunner	PFC	None	Armor AIT	1 yr	No
(n)	TC	SGT	TC School	Armor AIT	2 yrs	No
	Gunner	PVT	None	Armor AIT	1 yr	No
(o)	TC/Plt Ldr	2 LT	None	AOBC	4 mos	No
	Gunner	PV2	None	AIT	1 yr	No
(p)	Gunner	PFC	None	AIT	1 yr	No
	Gunner	PV2	None	AIT	1 yr	No
	Gunner	PV2	None	AIT	18 mos	No
(q)	Driver/Gunner	PFC	None	AIT	14 mos	*
	Driver/Gunner	PFC	None	AIT	1 yr	*
(r)	TC	SP4	None	AIT	8 mos	*
	Gunner	PFC	OJT	AIT	18 mos	*
(s)	TC	SP4	OJT	AIT	17 mos	No
	Gunner	PV1	OJT	AIT	16 mos	*
(t)	TC	SP4	OJT	AIT	4 yrs	*
	Gunner	PFC	OJT	AIT	18 mos	*
(u)	TC/Plt Ldr	2LT	None	AOBC	10 mos	No
	Gunner	PFC	None	Armor AIT	15 mos	No

**TOW School refers to a 10 day course at Ft Polk, Louisiana which covered the use of the TOW and all its mountings (APC, ground, mule, ¼ ton truck).

PLAYERS	POSITION	RANK	SPECIAL TRAINING	SCHOOLING	ARMOR EXPERIENCE	COMBAT EXPERIENCE
(v)	TC	SP4	None	*	30 mos	*
	Gunner	PFC	None	Armor AIT	15 mos	No
(w)	TC	SP4	TC School	Armor AIT	1 yr	*
	Gunner	PFC	None	Armor AIT	2 yrs	No

c. Defenders (2nd Armored Division).

PLAYER	POSITION	RANK	SCHOOLING	TOW EXPERIENCE
(1) TOW Crews.				
(a)	TC/Gunner	SGT	TOW School**	No live fire
	TC/Gunner	PFC	TOW School**	No live fire
	Gunner	SGT	TOW School**	No live fire
(b)	TC	SP4	None	None
	Gunner	PV2	TOW School**	No live fire
(c)	TC	SGT	None	None
	Gunner	PV2	TOW School**	No live fire
(d)	Gunner	SGT	None	None
(e)	TC	PV2	None	None
	Gunner	PFC	None	None
	TC	PV2	None	None
	Gunner	SGT	None	None

(2) Other crews, no data available.

d. Defenders (1st Cavalry Division).

(1) TOW Crews.

(f)	Gunner	SGT	None	None
(g)	Gunner	SP4	TOW School**	None
(h)	Gunner	SP4	TOW School**	No live fire
(i)	TC	SSG	None	None
(j)	Gunner	PV2	TOW School**	No live fire
(k)	TC	SGT	AIT	No live fire
	TC/Gunner	SP5	None	None
	Gunner	PFC	TOW School**	No live fire

(2) Dragon Crews.

(1)	Gunner	PV2	None	None
	Ass't Gunner	SP4	None	None

PLAYER	POSITION	RANK	SCHOOLING	TOW Experience
(3) M551 Crews.				
(m)	Plt Sgt/TC	SFC	Adv Tank Gunnery Sch. 6 wks Adv M551 Sch 6 wks Scout School 8 wks	6 yrs on M551
	Gunner	PV2	Armor AIT (3 wks on M551)	1 yr on M551
	Driver	PFC	None	4 mos OJT
(n)	TC	SGT	Sheridan Sch Adv Sheridan Sch	3 yrs
	Gunner	PFC	AIT	None
	Driver	PV2	AIT	None
(o)	TC	SP5	Sheridan	5 yrs
	Gunner	PV2	AIT (Took 1st place in gunnery)	1½ yrs
	Driver	PFC	Turret Mechanic Sch	1 yr
(p)	Plt Leader	2LT	Armor Officer Basic Course	

5. **QUESTION 8.** What is the most significant cue leading to a detection of a target?

(1) Tank commanders and gunners (2nd Armored Division).

(a) Flash, movement. Crews were cued by other tanks getting killed. The crews learned some of the likely defensive positions.
(b) Smoke.
(c) Smoke - noises would draw your attention to it.
(d) Smoke.
(e) TC - movement and people, Gunner - people.
(f) The movement of people.
(g) TC noise and smoke. Gunner - smoke.

(2) ATGM vehicle commanders and gunners.

(h) Smoke and people.

(3) ICV commander/driver.

(i) Movement - personnel and smoke.

(4) Tank commanders and gunners (1st Cavalry Division).

(j) Flash and glint of weapon system and smoke.
(k) Smoke and flash.
(l) Smoke.
(m) Smoke.
(n) DRAGON - terrain oriented. Smoke.
(o) Differs as to mode of attack: Fire + Maneuver - movement and likely spots. Rapid approach - flash and smoke.
(p) Smoke.
(q) Flash, smoke, and noise.
(r) Personnel movement - particularly around the DRAGON positions. Also, camouflage around vehicles not appropriate for background.
(s) Smoke and random sighting; also seeing personnel.
(t) Smoke and movement of personnel and B-unit antennas.
(u) Smoke.
(v) Movement - personnel.
(w) Flash and smoke also receiving a "survive" (light)*.

---

*See reference 1, VOL VIII, Annex B.

Annex 2 to Appendix A

ANALYSIS OF THE TETAM AREA OF OPERATIONS (SITE A)

Reference: Map, Alder Peak, Series V895, Sheet 1755 IV NE, 2-AMS, Scale 1:25,000.

1. PURPOSE AND LIMITING CONSIDERATIONS.

a. Purpose. The purpose of this analysis is to provide insight into the characteristics of the terrain called "Site A" and the possible influence of this terrain on attacker and defender courses of action in the TETAM Phase III trials.

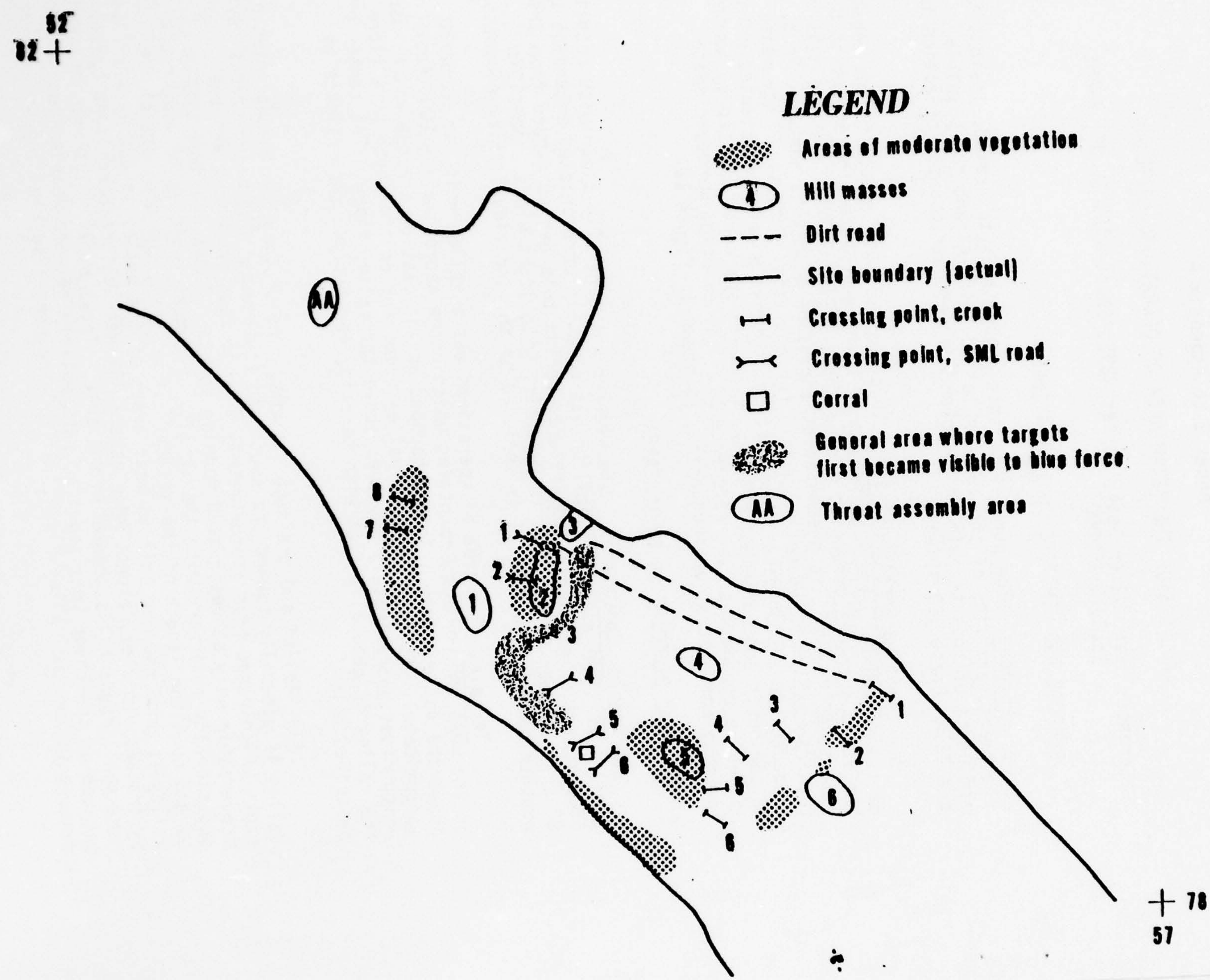
b. Limiting Considerations. This analysis is limited to the aspects of the terrain on Site A which appear to have effected the execution of the various trials conducted during Phase III of TETAM. (An analysis of the aspects of "Site B" is presented at Inclosure b to this annex.) Thus, the information is useful primarily for analysis of tactical movements conducted in a southeasterly direction, against a defense oriented primarily to the north and northwest. Actual maneuver space was limited by administrative boundaries (see reference 1). The existing maneuver space, ignoring administrative boundaries, is shown in figure 12.

2. GENERAL DESCRIPTION OF THE AREA.

a. Weather Conditions. The weather was generally clear with occasional periods of light rain. Visibility was normally unrestricted extending to 5000 meters or greater. Temperatures during this period ranged from the 80's in October to the 30's in December, with light winds. Specific weather data for each trial is included in the individual trial documentation.

b. Terrain. The area of operations was a valley which is bordered on the west and north by mountains which range approximately 2000 feet above the valley floor. It was bounded on the east by a ridge which rose approximately 400 feet from the valley floor and on the south by a ridge which rises approximately 300 feet above the valley floor. The center of the valley is generally flat with terrain, vegetation, and drainage as described below.

(1) Relief and drainage systems. The drainage in the Nacimiento Valley is generally toward the south and southeast. The major creeks have banks which range from approximately 5 to 15 feet in height and are traversable only at designated fording points. These drainage systems occasionally interfere with the ability of combat vehicles to move rapidly up and down the length of the valley. In general, the drainage of the valley is good and the soil in most areas of the valley is easily trafficable by tracked vehicles, except when especially wet weather conditions prevail. Many small round hills abound in the area. These small hills are important because of the cover they provide, particularly between weapons mounted or maneuvering on the valley floor. All of the ridges surrounding the valley


LEGEND
Areas of moderate vegetation
Hill masses
Dirt road
Site boundary (actual)
Crossing point, creek
Crossing point, SML road
Corral
General area where targets first became visible to blue force
Threat assembly area
AA
78
57

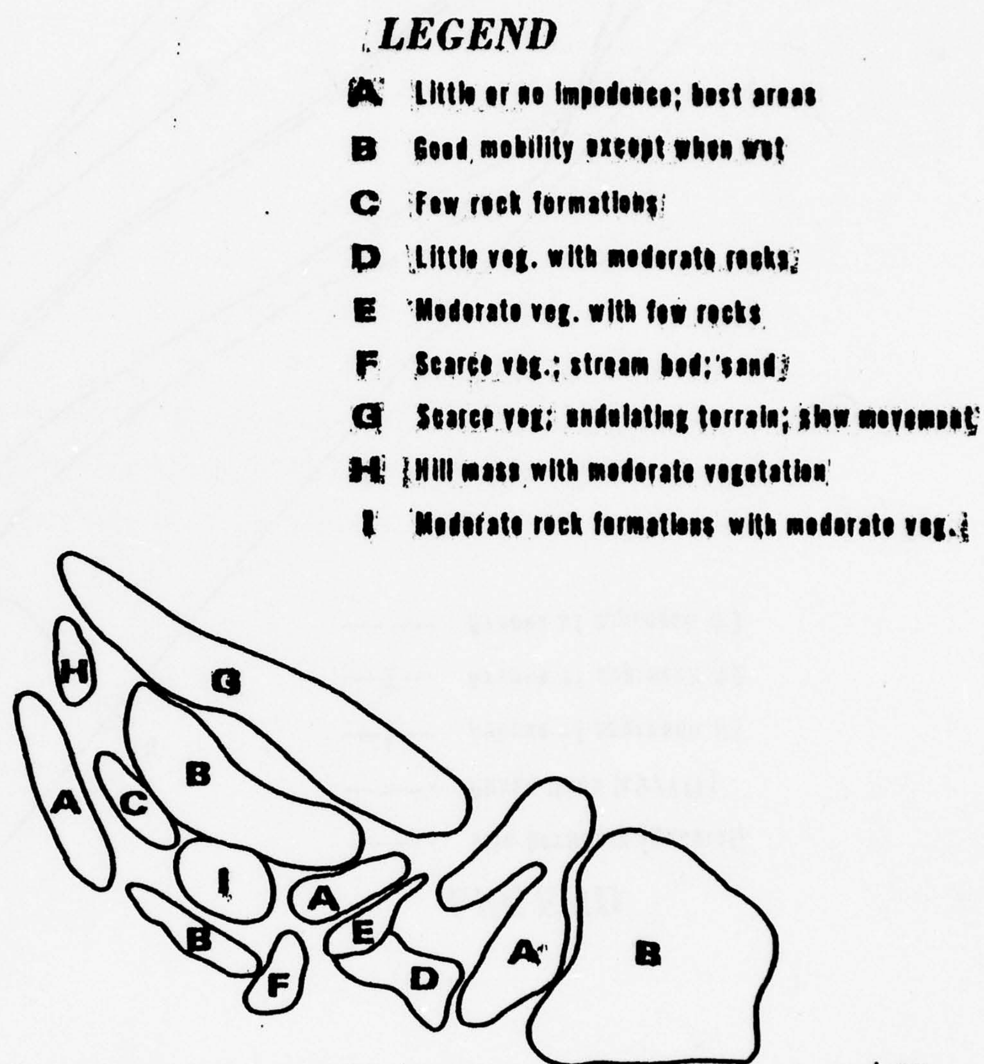


Figure 13 . Terrain and mobility characteristics, Site A

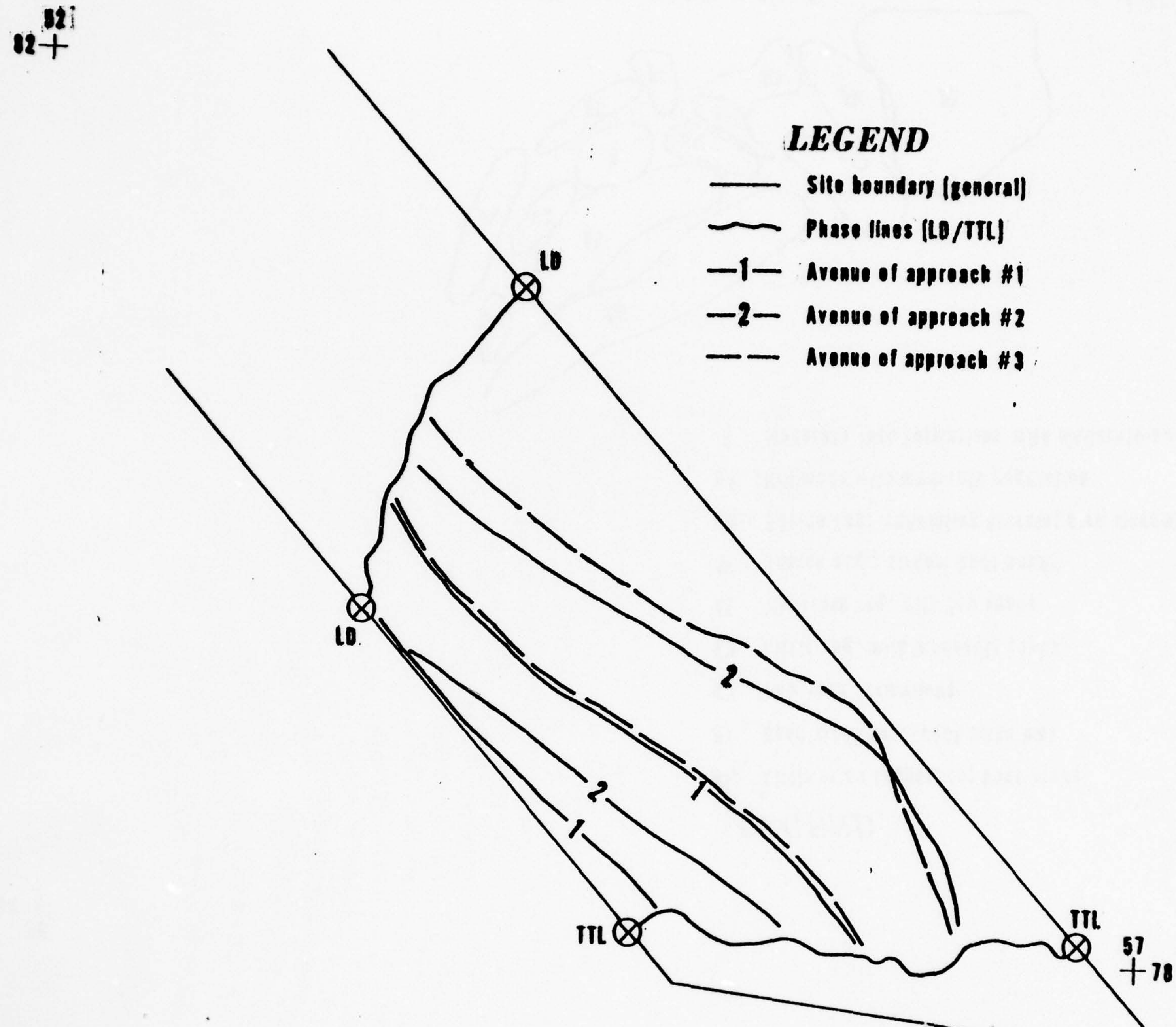


Figure 14. Avenues of approach, Site A

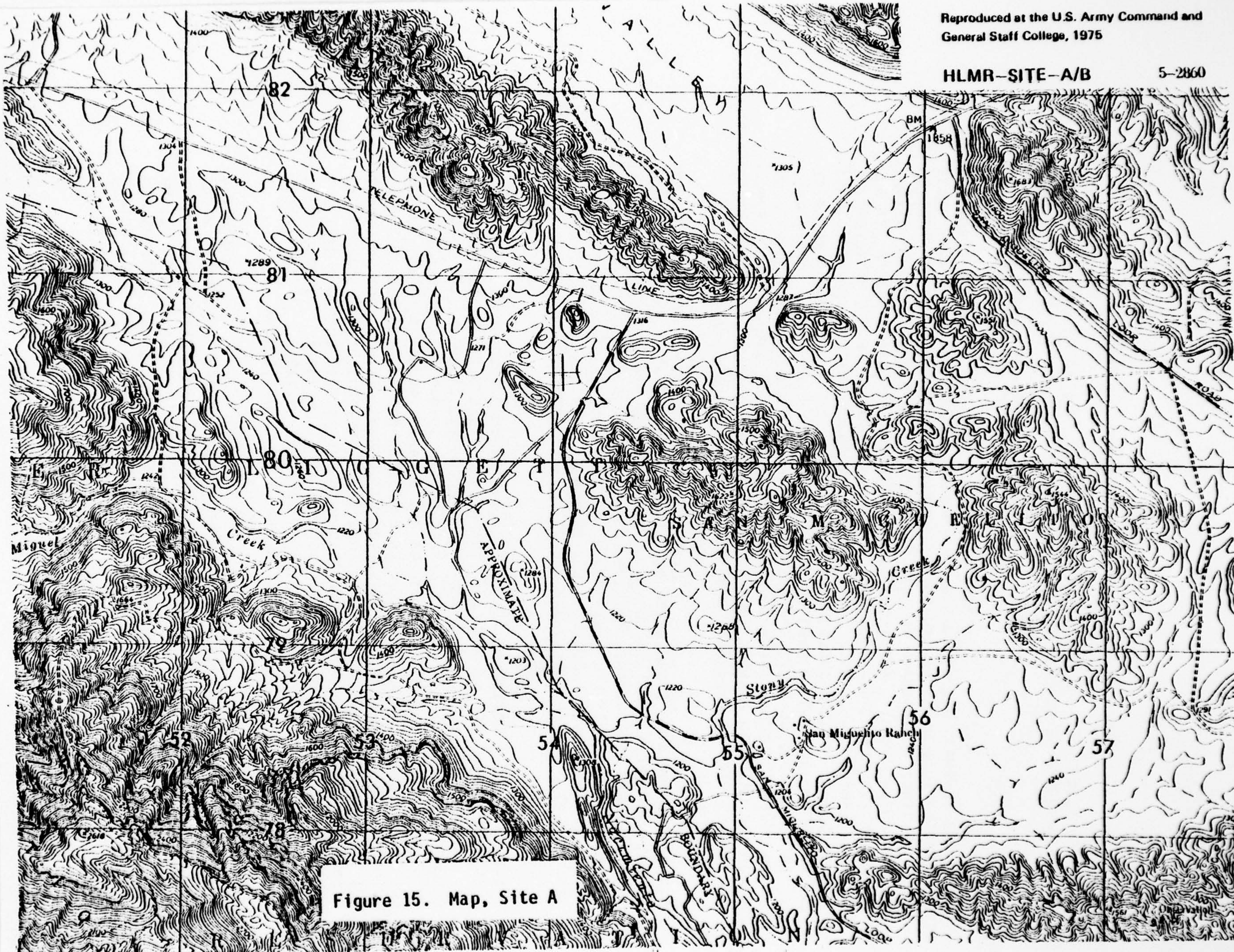


Figure 15. Map, Site A

dominate any approaches thereto. The ridge at the south end of the valley was selected for TETAM defensive positions (Site A). Other defensive positions were later placed at the north end of the valley floor (Site B). None of the Site B defensive positions were anywhere near as dominant over their respective approach routes as those located on the defensive ridgeline.

(2) Vegetation. There are large trees located on the defensive ridgeline. The vegetation in the valley was located primarily along the major creeks. It appears that much of this vegetation has developed since the last time the maps of the Hunter Liggett Valley was field checked. Large, widely dispersed oak trees provided occasional concealment in the center of the valley. Some of the hilltops on the valley floor also are vegetated and this caused considerable interruption to line of sight in the valley. The large trees on the valley floor are anywhere from 15 to 30 meters high with crowns approximately 25 meters wide located approximately 5 meters above the ground. The trees on the hilltops are somewhat smaller than those in the valley floor and the trees located along the creekbeds are young, fairly dense growth from 5 to 10 meters high.

(3) Surface materials. The surface of the valley floor varies from sand in the principle streambed (the Nacimiento River) to clay and rocky outcroppings in the vicinity of the small hills. Nearly all areas of the valley are trafficable in dry weather, however, the speed of trafficability is related to the depth of the various streambeds, the distribution of rock formations, and the embankments of roads in the area being traversed. (See figures 12 and 13.)

(4) Man-made features. There were very few man-made changes to the topography in the Nacimiento River Valley. There were two all-weather roads the traversed the valley, two or three small adobe buildings which were in ruins, and some improved defensive positions on the defensive ridgeline. There was a corral located at a bend of the San Miguelito Loop Road WNW of the ruins and it occasionally contained cattle. There were several trails located throughout the valley, most of which were developed by the large number of combat vehicles, particularly tanks, which traversed the valley through all types of weather conditions. These unimproved tank trails were one of the main factors in slowing movement of vehicles in the valley. In addition, the all-weather roads had banks in many places. These banks were protected administratively by orders to the crews to not cross the roads except at approved crossing points.

c. Additional Characteristics.

(1) The Nacimiento Valley was used as pasture by ranchers in the area. During many of the trials conducted in the valley, cattle wandered freely about.

(2) During the late fall, the high mountains to the west of the valley cause the valley to darken relatively early in the afternoon. This was specifically noted during one trial (see reference 1).

3. MILITARY ASPECTS OF THE AREA.

a. Tactical Aspects.

(1) Observation and fields of fire.

(a) Defending force. The high ground occupied by the defenders provided them with excellent observation out to approximately 3000 meters, permitting coverage of the approaches into the area with long range fires. Observation and fire is split by hills and vegetation in the vicinity of the ruins (554786). (See figures 12 and 15.) Observation at ranges greater than 3000 meters was generally restricted, and the attackers had unimpeded movement on fairly well concealed routes from the assembly area to the Line of Departure (LD). Observation from the objective out to 3000 meters was interrupted in some areas by several small hills, and intermittent vegetation. Areas into which long range observation was possible are annotated on figure 12 (see also figure 15).

(b) Attacking force. Same as above, except that several small hills in the area provided excellent observation of the objective (see paragraph (4)).

(2) Cover and concealment.

(a) Defending force. Cover and concealment for the defending force was excellent. The area in which the defensive positions were located was generally heavily vegetated, except along the topographic crest of the defensive ridge. Positions affording long range observation, fields of fire, and mutual support were available on the ridgeline and on the front slopes along the FEBA trace. The positions to the southeast were higher up on the ridge, exposed and more difficult to conceal than those to the northwest. The positions to the northwest (below the crest and on the front slopes of the ridge) afforded concealment at the cost of some observation and fields of fire. Many positions had been prepared by the engineers and were dug out, with berms in front affording hull defilade emplacement for the Shillelaghs and M-113 mounted TOWs. Fallen logs (approximately 3 feet in diameter) and streambeds to the north and west of the ridge on the valley floor afforded cover for the DRAGON positions. The defenders made extensive use of camouflage and vegetation to improve their concealment.

(b) Attacking force. The wooded area between hill 1284 (53857942-#1 in figure 12), hill 1485 (53938035) and the Nacimiento River bed provided excellent covered and concealed approaches to the LD. From the

LD to the objective, limited cover and concealment was provided by several small hill masses (see paragraph (4)), sparse vegetation, and several creek beds. Areas of cover and concealment are annotated on figure 12.

(3) Obstacles.

(a) Defending force. None.

(b) Attacking force. There were no major obstacles in the area. All creeks are fordable, but only at the crossing points annotated on the attached map. These points are also listed below. No traffic was allowed on the San Miguelito Loop (SML) road except at the crossing points shown on figure 12. No players are allowed on the ridges on the eastern boundary and western boundary. Soil trafficability was generally good (see figure 13. The corral at grid coordinates 54487870 was not to be damaged. (Travel through the corral was restructed to points where gates were open, however the corral was generally by-passed to the west.)

Table 18. Stream and creek crossing points.

CROSSING POINTS	
CREEKS	SML ROAD
1. 557789	1. 541796
2. 555787	2. 541795
3. 552788	3. 541792
4. 550787	4. 542790
5. 549785	5. 543787
6. 549784	6. 544786
7. 538797*	
8. 538799*	

*LD Crossing Points

(4) Key terrain features.

(a) Hill 1284 (53857942 - #1 in figure 12). This was a hill mass covered with sparse vegetation. It provided fairly good long range observation of the objective, however, it was unsatisfactory as an overwatch firing position because it was generally out of SAGGER range to the defensive positions. The base of this hill was the first area where the attacking force became visible to elements of the defending force located on the defensive ridge (objective).

(b) Hill (54197950 - #2 in figure 12). This hill mass was covered with moderate vegetation and provided limited observation of the objective. (Observation of the objective was restricted primarily by hill 1268 - see paragraph (c)). It provided cover and concealment for the attacker approaches to SML road from the LD.

(c) Hill 1310 (54317973 - #3 in figure 12). This hill actually a finger extending down from the eastern ridge, was covered with sparse vegetation. It provided good observation of the eastern half of objective; however, it was generally out of SAGGER range to that portion of the objective.

(d) Hill 1268 (54877912 - #4 in figure 12). This was a prominent hill mass in the center of the site and was covered with moderate vegetation. It provided good observation of the objective area and was an adequate overwatch position and a good checkpoint. It was a good reference point for the defending force.

(e) Hill (54697869 - #5 in figure 12). This was a small hill with moderate vegetation and several rock outcroppings. It provided excellent close-in observation of the western half of the objective and limited observation of the rest of the objective. It also provided some concealment for maneuvers by the attackers when they were close to the objective.

(f) Hill (55457855 - #6 in figure 12). This was a prominent unvegetated hill mass, close to the objective. Maneuver on top of this hill was restricted by an A-station (see annex B to VOL VII, reference a). This hill provided some masking for maneuver of the attack force. It was not a good overwatch position because of its lack of vegetation, and it was a good reference point for the defenders.

(g) Creek, 56987812-55357806. This creek generally served as the trial termination line (TTL) for the area east of San Miguelito Loop Road.

(h) Creek, 55637842-55757862. This portion of a longer creek was characterized by high, steep banks. There were no crossing points, so this area was impassable.

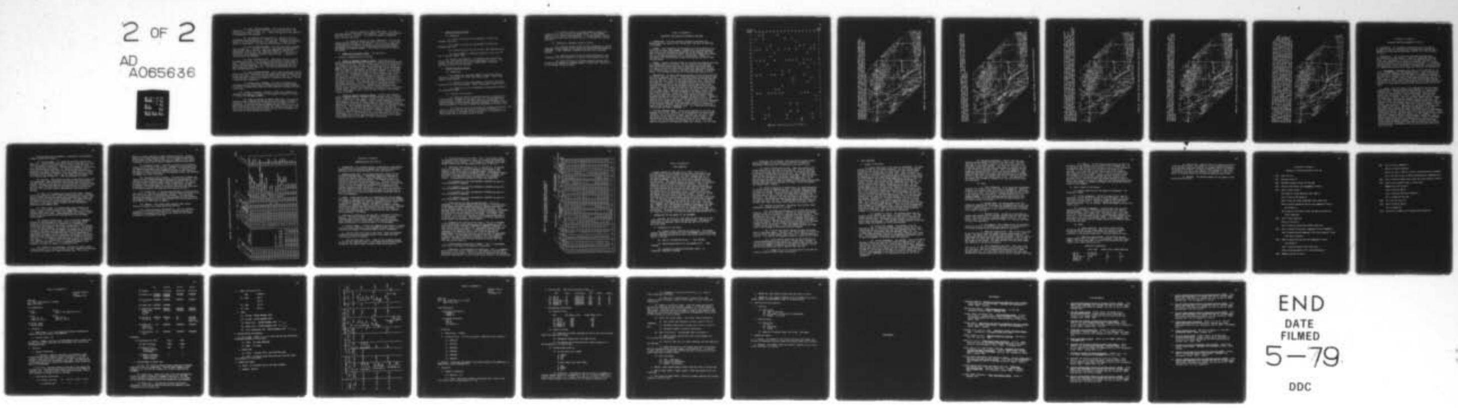
(i) Creek, 54957848-55747910. This creek was fordable only at the crossing points shown on the map. In some areas, the creek banks were 10-15 feet high. In the area of 55437876-55737895, a thick tree line bordered the creek, and provided limited cover and concealment to the creek approaches and the crossings, and for firing positions chosen in this vicinity. The creek was an excellent phase line for the attackers and was a reference point for the defenders.

AD-A065 636 ARMY COMMAND AND GENERAL STAFF COLL FORT LEAVENWORTH KANS F/G 9/2
A METHODOLOGY FOR INTERFACING COMPUTERIZED COMBAT MODELS AND FI--ETC(U)
JUN 78 J R STATZ

UNCLASSIFIED NL

2 OF 2

AD
A065636



END
DATE
FILMED
5-79
DDC

(j) Creek, 53527916-53738050. This creek was usually the attacker LD. It had high banks (10-15 ft) and was crossed only at the crossing points shown in figure 12. These crossing points were generally not observable by the defenders.

(k) San Miguelito Loop Road (SML Rd). SML Rd is the only all-weather road crossing Site A. Traffic was not permitted on the road except at the crossing points shown in figure 12, although the attackers did use it occasionally. The road was characterized by high shoulders.

(l) Road, 54127970-55807892. This dirt road (shown by dashed line in figure 12 provided a relatively high-speed, exposed approach along eastern side of the area. Speed was hampered in some areas by undulations in the terrain and intermittent creek beds. There was very little cover and concealment available along the road. It served as a reference point for defenders.

(m) Road, 54617960-55517914. Approximate location is shown by dashed line on map. This dirt road traversed the far eastern edge of area. Intermittent cover and concealment was provided by undulations of terrain and some vegetation. This road passed by some dugout positions used in previous trials (Phase II). This road provided access to some good overwatch positions.

(n) Road, 54797816-55757905. A dirt road traversing the entire width of the site. The portion of road between the western boundary and SML Rd was often used as the LD for attacker forces west of SML Rd. The portion of the road east of SML Rd could serve as an attacking force phase line and a defending force checkpoint.

(o) Assembly area, 53088090. This area was concealed from the defensive force. Attacking units assembled here by maneuver elements. Last minute instrumentation checks and task organization changes were made in this area.

(5) Avenues of approach. Generally, there were 3 company size (500-800m wide) avenues of approach to the objective (numbered 1 through 3 in figure 14 from west to east).

(a) Avenue of approach #1 (approx 500m wide). This was the shortest avenue of approach to the objective and was roughly bisected by the SML Rd. The only variation in elevation was provided by Hill #5. Concealment was provided by moderate vegetation east of SML Rd and at the base of the western ridge, and by several rock formations around Hill #5. This avenue of approach was more suitable for the fire and movement (FM) tactic than the rapid approach (RA) tactic.

(b) Avenue of approach #2 (approx 800m wide). This was the widest avenue of approach to the objective. Dominant terrain features were hills #1, 2, 4, 5, and 6. This avenue of approach accommodated either the RA or FM tactic.

(c) Avenue of approach #3 (approx 600m wide). This was the longest avenue of approach to the objective. Hills #2, 3, 4, and 6 were the dominant terrain features in the area. There was sparse vegetation and undulations of terrain on the eastern edge which provided limited concealment, but hampered movement. The RA tactic was most suitable for this avenue.

b. Combat Service Support Aspects. Not applicable.

4. EFFECTS OF CHARACTERISTICS OF THE AREA.

a. Effects on Defender Courses of Action. High ground in the objective area and excellent visibility of all avenues of approach favored the defense of the area. However, limited assets with which to defend the large objective occasionally required the defending force to spread its weapons 1000 or more meters apart. Observation and fire for the defender ATMs (and avenues of approach for the attackers) were split by the rocky hills and trees (vicinity 547787 and the ruins, 554786). This required disposition of the defending elements to insure coverage of each side of the split zone. The defensive ridgeline ran from east to west, while the avenues of approach ran from northwest to southeast, so positions on the west side for the FEBA were as much as a kilometer forward (NW) of the eastern positions. The large open area to the immediate front (N) of the eastern positions on the ridgeline could be covered by almost any of the center and western positions. Therefore, the positions on the western half of the defensive position were used by defensive force platoon leaders (based on their experience in previous trials) to maximize the ATM range capability and to cover the most frequently used attacker avenues of approach.

b. Effect on Attacker Courses of Action. The best rapid approach avenue of approach was #2. The best fire and movement avenue of approach was #1. Weather had little effect on attacker courses of action, since trials were not run in bad weather. Areas of sparse vegetation necessitated rapid movement, especially at longer ranges, so that the attackers could maneuver to within the effective range of their weapons without sustaining heavy losses. Rapid movement degraded the ability of the attackers to obtain paired firings, thus reducing the volume of effective fire onto the objective. The numerous hills and areas of moderate vegetation favored the use of ATGMs in overwatch positions. As a result, the use of the fire-and-movement tactic, the skirting of open areas when possible, and very rapid movement across those open areas that could not be skirted appears to have been best way to conduct an attack on Site Alpha.

c. Attacker Courses of Action.

(1) Enumeration.

(a) Attack utilizing fire and movement to envelop the defenders west flank.

(b) Attack utilizing fire and movement to envelop the defenders east flank.

(c) Attack along the front utilizing a rapid approach tactic.

(d) Employ SAGGERs in overwatch positions at any time with any of the above capabilities.

(2) Analysis and discussion. The attackers were required to use both the rapid advance and fire and movement tactics equally. They favored the west flank, and occasionally used SAGGERs in overwatch positions on either side of the zone.

d. Defender Courses of Action.

(1) Enumeration.

(a) Defend with long range weapons in relatively exposed positions on high ground with broad long range coverage. (Short range weapons placed forward.)

(b) Defend with long range weapons in relatively concealed positions with restricted coverage. (Short range weapons placed forward.)

(c) Defend with a mix of exposed/high coverage and concealed/low coverage positions.

(2) Analysis and discussion.

(a) Course of action (a) provided excellent coverage against either attacker envelopment of the east flank, or his rapid approach all along the front. However the high ground positions were exposed, likely to be anticipated by the attackers, and were vulnerable to overwatch firing tactics and were of little use in preventing envelopment of the west flank.

(b) Course of action (b) provided fair coverage well forward, with relatively better survivability against the attacker overwatch tactic. However, some gaps or dead space existed, especially in the center of the zone, against any of the enemy courses of action.

(c) Course of action (c) provided adequate coverage with minimum risk of loss of the entire defense force. It was somewhat vulnerable to an attacker rapid approach. It limited defender losses to ATGMs using overwatch tactics against some of the exposed/high coverage positions.

(3) Comparison of defender courses of action.

(a) Course of action (a) had the major advantages of insuring engagement of many targets at long range, but it was often anticipated by the enemy. It was vulnerable to attack on the west and to overwatch tactics.

(b) Course of action (b) had the major advantages of high concealment, but was vulnerable to an attack in the center of the zone.

(c) Course of action (c) provided adequate coverage while minimizing the exposure of selected elements, insuring their availability for use through the entire attack.

Annex 3 to Appendix A

DESCRIPTION AND ANALYSIS OF DEFENSIVE POSITIONS

1. INTRODUCTION. This annex contains information describing the defensive positions used on Site A during Phase IIIB and E of Experiment 11.8 (TETAM).

2. PURPOSE. This information was developed to more fully describe trial conditions for model input purposes. Essentially, this annex provides a word picture of the strengths and weaknesses of the defensive positions used in the Phase IIIB and IIIE trials. Any conflict between this information and published experimental data is unintentional; however, no experimental data has been found to date which provides the type of data included herein.

3. GENERAL. Several different methods for analyzing the defensive positions were attempted during this effort. The only picutes of the positions that were available were those taken of the general area during Phase I. As a result, the position descriptions become very complicated, and only the information which is useful in the model setup procedure is presented herein. This information relates only to the positions used on Site A.

4. ORGANIZATION. The annex contains descriptions for each of the positions used during subphases IIIB and E. These descriptions are annotated on maps that also show the firings that took place from the trial 96 positions for <u>all</u> Phase IIIB and E trials in which the position was used. (See figures 16 through 20.) In addition to the graphic protrayal of the firings that occurred during the trials, two inclosures to this annex describe the estimated vulnerability and the estimated effectiveness of each position, respectively. Table 19 shows the positions, and the weapons that occupied them, for each trial listed across the top of the table. The cell entries are the weapon numbers, and they correspond to the weapons shown in the time lines of figure 8. Figures 16 through 20 show the paired firings both <u>by</u> the weapon (dots and straight lines) and <u>at</u> the weapon (crosses) occupying the position for <u>all</u> the Subphase IIIB and IIIE trials. Generally speaking, the start of a line on a position-description figure is the point at which a target was detected. The end of the line is the approximate location of the target vehicle when the round, which was fired as a result of the detection, impacted. Dots show either a firing at a stationary target or the firing of a subsequent round. The firing data were obtained from the data published in reference 1.

5. POSITION NUMBERING SCHEME. The positions described in this annex are numbered from 1 to 48. Positions 1 to 36 correspond to the Phase I panel locations. Most of the Phase I (panel) positions were not used in Phase III and many of the Phase III positions were not used in Phase I. The additional positions (those used only in Phase III) are numbered from right to left (by decreasing x-coordinate) from 37 to 48. For a more detailed discussion of the numbering scheme, see inclosure 1 to this annex.

Position Number	24	28	29	32	34	35	36	38	72	73	77	79	80	92	96	97	98	TIMES USED
1		20	20				20											3
10	20		18						20		21							4
16												21						1
21					20								18	19			18	4
22	19	19		18			19		21	19		18				19	19	9
27						19									18			2
28					18													1
29	18	18	19			18			19	18	18	19		21	21	21		11
30				20									21	18			21	4
33															19			1
35								18		21								2
36	22	22			24	24		24						24				6
37											23					18		2
38											24				23			2
39								23										1
40						23	23											2
41	23	23		19	19	20	18	20					19	23	24			10
42																	23	1
43																	24	1
44										24		24						2
45				24														1
46										23		23						2
47			23	23					23							23		4
48			24						24				23/ 24			24		5

Table 19. Position use, by trial (Site A).

Position 27. This position was on the east side of a knoll topped by an instrumentation (A-Station) tower. Trees on the hill offered some concealment, but the position's primary protection was provided by the hill itself, which intervened between the position and primary killing zones on the west. It was an effective position only against attackers on the eastern approach to the defensive positions.

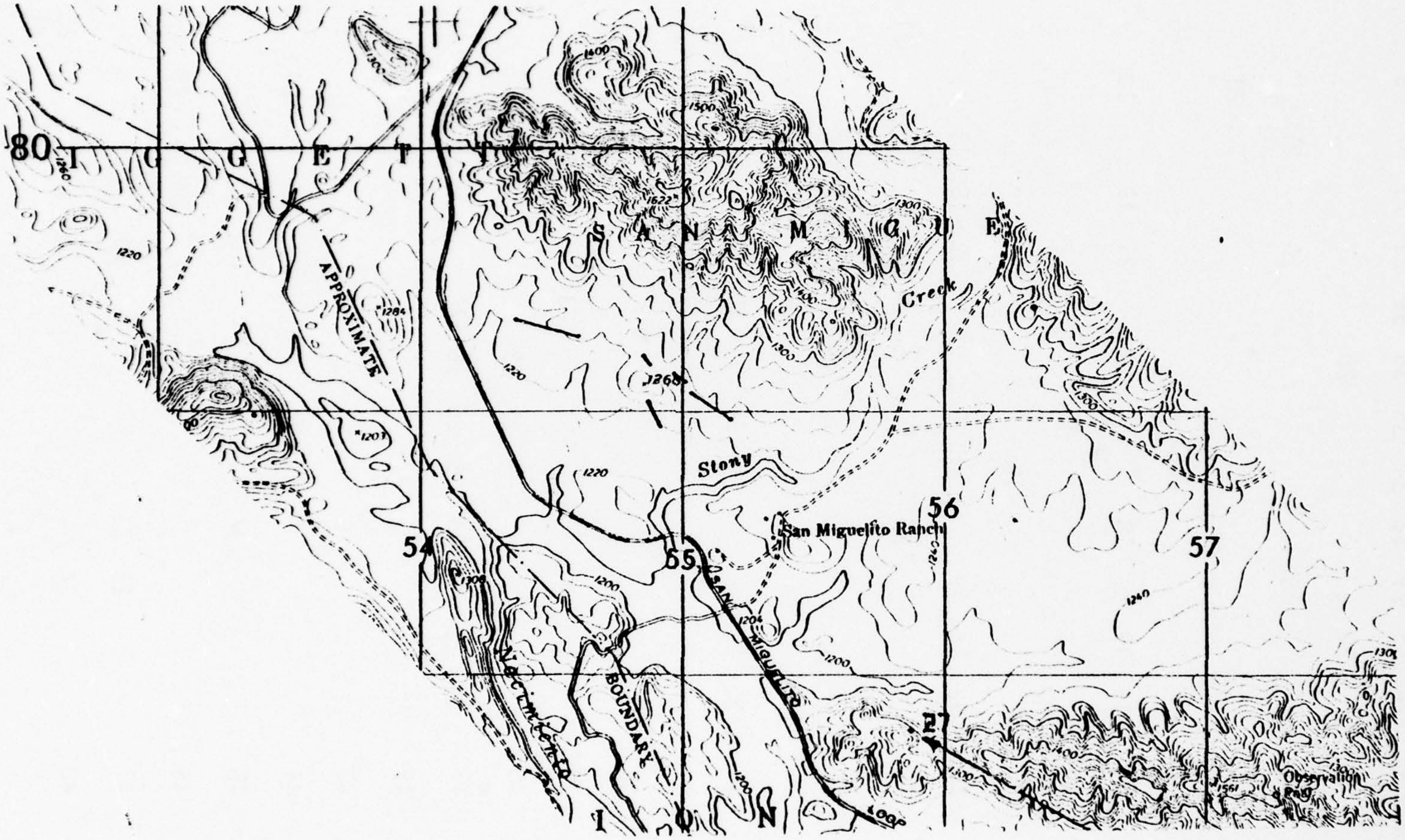


Figure 16. Detections, firings, and position description, Position 27.

Position 29. This position was used so frequently, it was undoubtedly well-known to the attacker. It had excellent observation and a "hull-down" dugout. It was situated on a rocky knob with good fields of fire into primary killing zones, but gave up 500 or so meters of range stand-off to the area where the threat force would usually first appear.

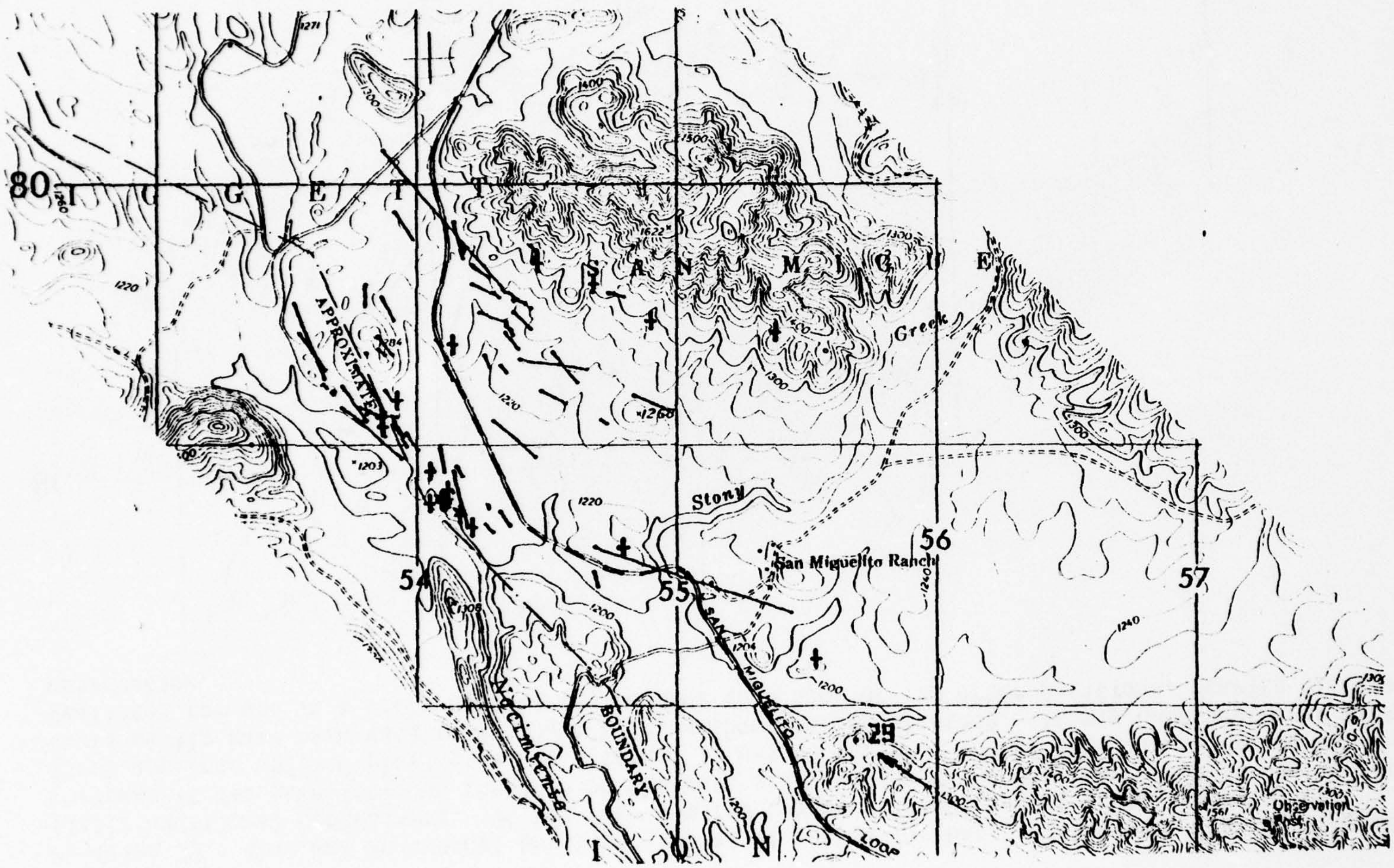


Figure 17. Detections, firings, and position description, Position 29.

Position 33. This was an unusual position in that it was so far back in the trees that it required little additional concealment. It had very limited coverage in the target area. However, the coverage it did have included the area on the west side, beyond the corral where most threat forces first appeared while deploying in the attack. It was on the west end of the main ridgeline and could easily have been vacated during a trial without enemy detection. It may have been more tactically realistic for use in a truly hostile environment than some of the other positions, despite its limited observation.

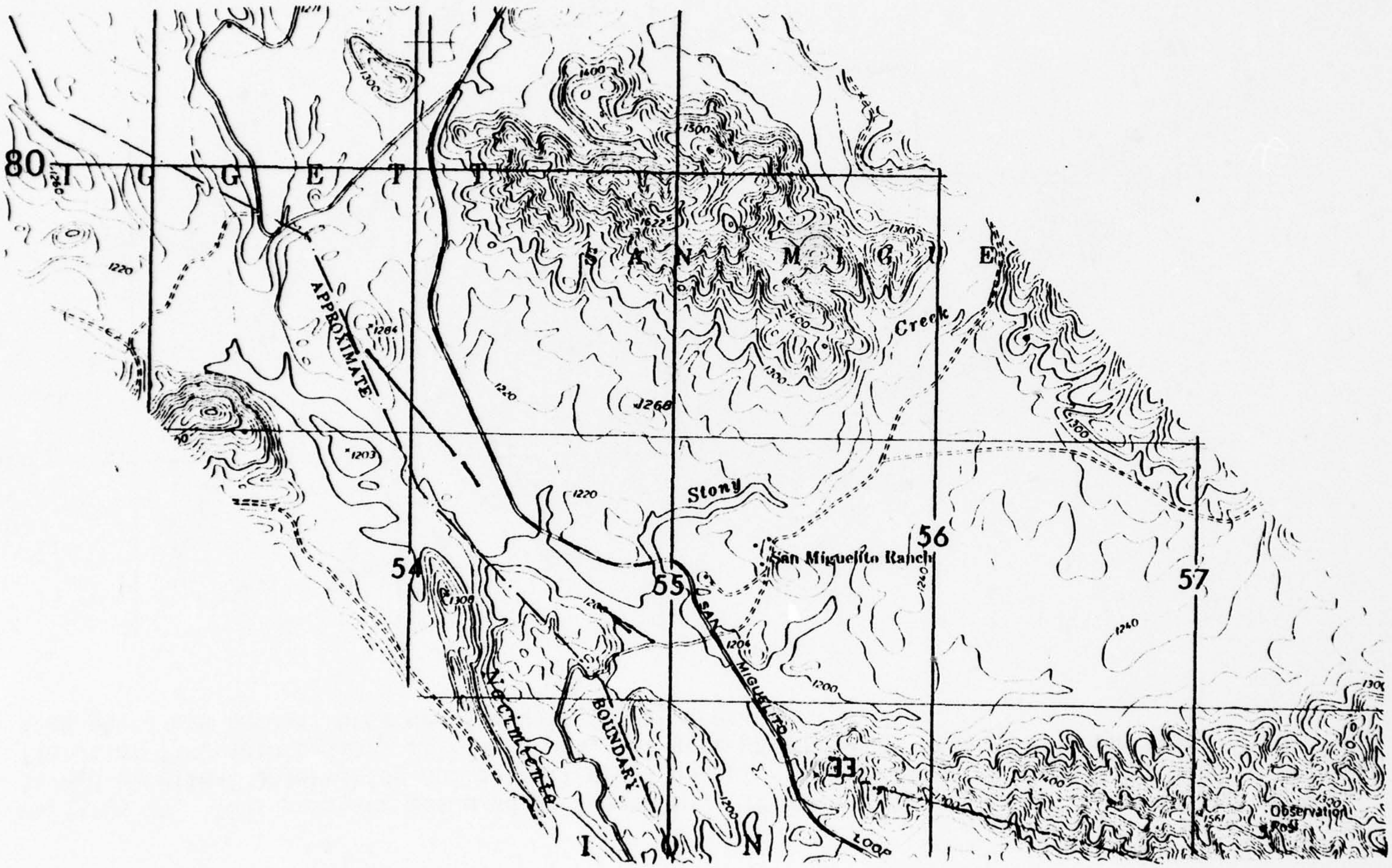


Figure 18. Detections, firings, and position description, Position 33.

Position 38. This was a Dragon position hidden in fallen branches beneath a large tree. This tree stood out from its surroundings and probably attracted attention to the position beneath it. A nearby creekline offered a covered withdrawal route for the Dragons, had they been able to move. There were flat fields of fire out toward the corral and toward the last 1,000 meters of the west approach.

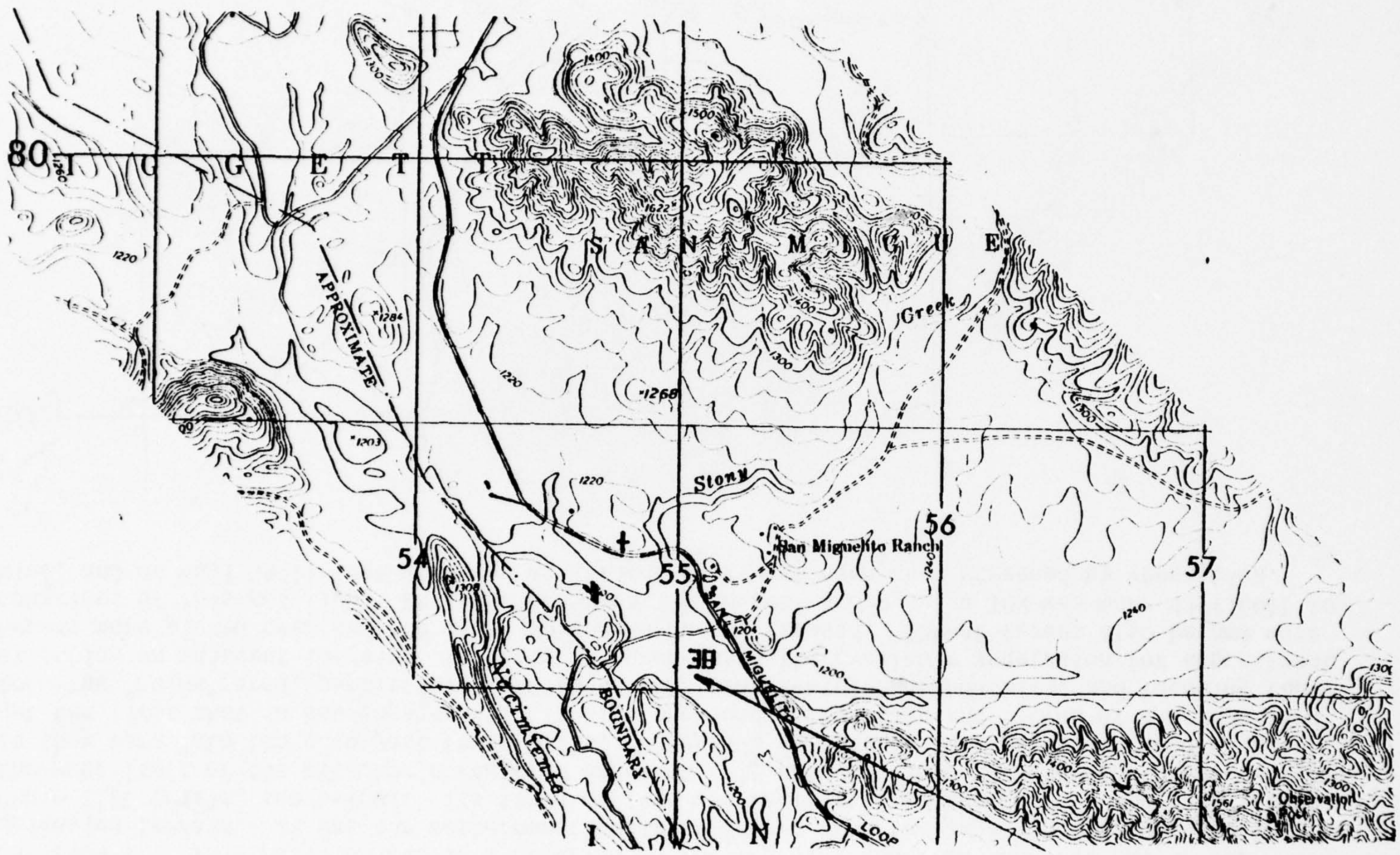


Figure 19. Detections, firings, and position description, Position 38.

Position 41. This position was in a clearing on the top of a knoll on the west end of the defensive terrain. It was the westernmost position (other than the ambush positions used in Phase IIIE trials, see below). Its field of fire was restricted on the west by the hills along the west limit of the attacker's route of approach. It provided some surprise to threat vehicles as they came into the open past these hills. Defensive weapons at this position could usually get the first shot in any engagement. It also provided observation and fields of fire eastward into the "ruins" area, permitting flank shots on threat vehicles approaching, and focusing their attention on adjacent terrain. As Phase III progressed the available vegetation for concealment became more picked over and the clearing more open and exposed. Threat forces also became more conscious of this position. While it could easily conceal a Dragon, a TOW was more difficult to hide, and an M551 Shillelagh appeared as a large dark mass even when screened by vegetation.

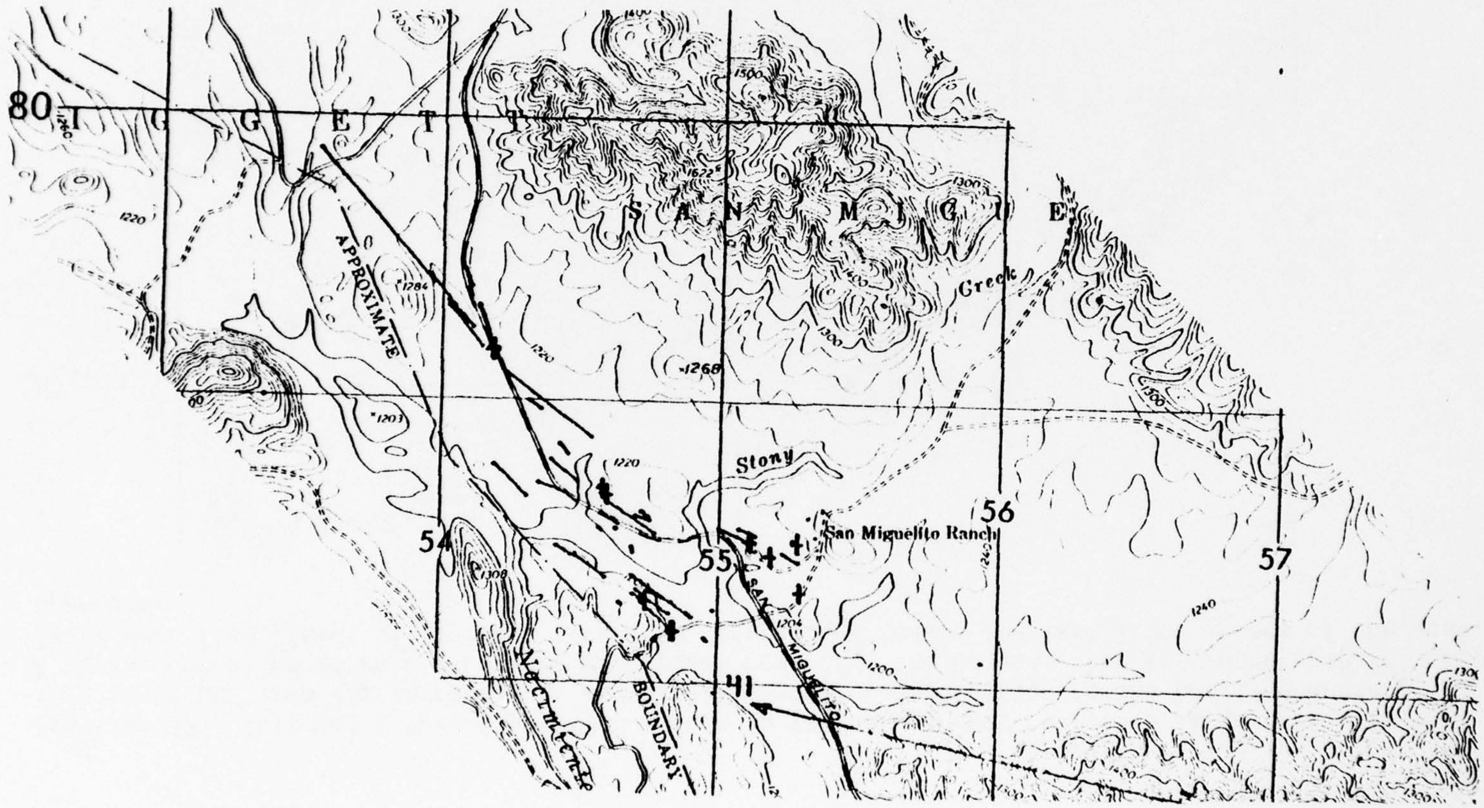


Figure 20. Detections, firings, and position descriptions, Position 41

Inclosure a to Annex 3

DEFENSIVE POSITION VULNERABILITY (SITE A)

1. INTRODUCTION. The information contained herein can be used to estimate the relative "vulnerability" of weapons which occupied the defensive positions used during Phases IIIB and IIIE trials conducted on Site A.

2. VULNERABILITY. The vulnerability assessment described below considers explicitly two factors: "cover", or protection from enemy fires; and "concealment", or protection from enemy observation. An intervening object serving as cover, or protection from fire, on many occasions should not also be considered as "concealment" , or protection from observation, since a sandy berm or prominent knoll may provide cover to a weapon position while at the same time increasint its detectability.

a. Concealment. Concealment was played in this experiment by its effect on player detection and engagement events. This discussion, and the descriptive information tabulated below, is intended to supplement the quantitative intervisibility and acquisition information obtained in Phases I and II of TETAM. Many of these same positions were used in all three phases of TETAM. Descriptions of cover and concealment consider each position as it was usually configured for trials. Some positions are assumed to be occupied by a particular ATM type exclusively (as was the case).

b. Cover. Cover was played in the experiment by basing casualty assessment on an exposed vulnerable area parameter, or "target aspect/ exposure state." Information on the exposure state was obtained by illuminating laser sensors, afixed to each weapon. When the lowest sensors were illuminated fir a firer's laser beam, the target was considered fully exposed. When only the upper sensor group on a target was illuminated, the target was assumed to be in hull defilade. Therefore, the actual cover available could be somewhat greater than that apparent in trial data because cover that was not high enough to obstruct a sensor group would not affect field trial casualty assessment. This was somewhat unrealistic. Camouflage nets and pieces of cut vegetation were often used to enhance the natural concealment at a position. Concealment could have had the effect of providing cover by inadvertently blocking some sensors. However, every effort was made to prevent "unfair" interference with the lasers and sensors. In fact, vegetation was cleared away when it seemed to unfairly inhibit sensor illumination. Thus, a weapon could be almost totally concealed behind a screen of camouflage net and vegetation and yet not be covered, both in reality and in the TETAM casualty assessment procedure. Control personnel down range normally observed preparation of positions for each trial and pointed out deficiencies in concealment which were then corrected prior to the start of a trial.

c. Position descriptive information is tabulated in the respective columns of table 20 as follows:

(1) Position number. This numbering system was used for this report only. The 36 ATM positions used in Phase I (intervisibility) were originally numbered on data cards from east to west along the ridge (i.e., decreasing x-coordinate). Positions which belonged to the original set of 36 are marked by asterisks. All additional positions used in valid Phase III record trials were west of the original 36 and are also numbered by decreasing x-coordinate. Thus, the numbers from 1 to 36 are consistent with the Phase I panels (see (4) below) and the numbers from 37 to 48 are unique to Phase III. (See also paragraph (3) below.)

(2) Location. Each position location is specified by eight digit grid coordinates. These coordinates were obtained from electronically recorded position data for the valid trials during which the position was occupied. Different coordinates for the same position in different trials may be caused by different specific positioning within the same unique position. For this table the most representative coordinates were selected.

(3) Phase III instrumentation and operations number. Because conflicting systems were used to number defensive positions for different phases of TETAM, the position numbers were supplemented by commonly used descriptions to facilitate on-site coordination. The numbers that are included here were used to interpret debriefing questionnaires, trial logs, etc., in which the original system(s) and the supplementary descriptions were commonly used.

(4) Phase I panel. Tri-colored panels were erected during Phase I for use in making intervisibility measurements. Thirty-six letters, numbers and circled single digit numbers were used to uniquely designate each of the panels. These designations are included in this column to correlate the positions discussed herein with the panels used in Phase I.

(5) Exposed vulnerable area. This is an entirely judgmental estimate of the percentage of frontal height of the weapon system occupying the position which was exposed to fire (uncovered) or observation (unconcealed) as seen from a vantage point in the vicinity of hill 1284 (Grid 53857942) in the center of the valley. The estimate is based on recollection and photographs, and assumes the position was occupied by the weapon type most commonly associated with the position. The estimate takes into consideration cover, natural vegetation (as camouflage) and commonly used cut vegetation that seemed to effectively obstruct attacker observation of the position at the time of the Phase III trials. It is a simple estimate which may be useful in concert with other factors. It is probably more valid when comparing this position with other positions than it is as an independent statement of the exposure of a particular weapon in a particular trial.

(6) Suitability for camouflage. Positions are rated by their relative capacity to be visually blended with their immediate surroundings, considering the weapons that commonly occupied them. This is not a

measure of either vegetation or target background contrast, although those are two closely related factors. It is a subjective description of the effects of these factors, and colors and shadows as they usually interacted to conceal the existence of weapons occupying the positions.

(7) Background clutter. Positions are rated by the background clutter in the vicinity of the position. Attempts to blend a weapon with its immediate surroundings are not considered here. For example, fallen logs fairly suitable for hiding a DRAGON at position 37 were located in the middle of a grassy area which had low background clutter, and therefore the DRAGONs were easily pinpointed.

(8) Intervening terrain features. This descriptor estimates the number of terrain features between the position and the attacker(s). Such intervening terrain features probably degraded the attackers ability to precisely locate the position under certain circumstances. For example, an attacker looking toward position 1 from the west could have been distracted by the target complex of positions 27-29 and by the undulations on the forward slopes of the ridgeline which contains position 1.

(9) Flanking fire. It may have been difficult to detect positions that were not in line with the attacker's primary direction of attack (i.e., not in line with where his attention was directed). This descriptor indicates the chances of the position being by-passed and thus affording the occupants the opportunity to place flanking fire on the attackers from about 500 mils off their axis of advance.

(10) Remarks. This column briefly presents other factors affecting vulnerability to enemy observation and fire.

(11) Overall estimate of detectability. This is a subjective assessment of the relative vulnerability of a defensive position to detection by an attacking force, taking into account all the factors considered in the columns to the left.

Table 20. Estimated vulnerability of the Site A defensive positions

(1) Position #	Location (UTM)	(2) Phase III Inst & Opn Number	(3) PH I Panel	% Uncov.	(4) % Uncon. (Exposed Vul. Area)	(5) Suit for Camflg**	(6) Background Clutter	(7) Intrvn Ter Feat	(8) Flanking Fire	(9)(10) Remarks	(11) Detectability
* 1	57207773	27	1	70	70	GOOD	HIGH	3d	SOME	RNG STANDOFF, REV SLOPE DUGOUT, SHADOWED	VERY HARD
*10	56747762	23	A	70	60	GOOD	MED	2d	NONE	RNG STANDOFF,ON RIDGELINE, SHADOWED.	HARD
*16	56497766	18	H	50	50	FAIR	LOW	2d	NONE	ON RIDGELINE, REV SLOPE DUGOUT	MODERATE
*21	56387774	13	P	90	80	POOR	LOW	1st	NONE	ON PROMONTORY BY LONE TREE	VERY EASY
*22	56357772	16	Q	30	30	POOR	LOW	1st	SOME	SKYLINED, REV SLOPE DUGOUT	EASY
*27	55877780	9	W	60	50	FAIR	MED	2d	NONE	ON HILLSIDE W/INSTR STA/TOWER. IN DUGOUT, SHADOWED.	MODERATE
*28	55807780	8	X	100	90	FAIR	MED	2d	NONE	ON PROMONTORY W/INSTR STA/TOWER, SHADOWED	EASY
*29	55697788	7	Y	40	40	POOR	LOW	2d	NONE	SANDY DUGOUT ON PROMONTORY	EASY
*30	55657789	6	Z	80	50	GOOD	HIGH	2d	NONE	IN ROCKS & TREES, HEAVY VEGETATION	HARD
*33	55567773	5	4	100	80	GOOD	HIGH	3d	NONE	TREES. SHADOW.	HARD
*35	55407799	2	6	100	50	FAIR	MED	2d	SELDOM	ON PROMONTORY IN TREES	MODERATE
*36	55387799	1	7	100	90	FAIR	LOW	2d	NONE	ON OPEN GRASSY HILLSIDE	EASY
37	55167821	WOOD PILE AT RD JCT		100	50	FAIR	LOW	1st	NONE	IN LOG PILE	EASY
38	55027807	1/2		80	50	FAIR	MED	1st	SELDOM	IN LOG PILE UNDER TREE	MODERATE
39	54997803	CREEK BED BY KNOLL OR "O"		70	50	GOOD	MED	1st	SOME	IN BRUSH AND STREAM BED OFF SIDE OF HILL	HARD
40	54987816	CREEK BED BY FORD OR ROAD		60	50	GOOD	MED	1st	SOME	IN CREEK BED. IN SHRUBS. SURPRISE.	HARD
41	54987798	0		100	70	FAIR	MED	1st	MUCH	IN CLEARING ON HILL. SHADOWED.	MODERATE
42	54717956	DRAGON AMBUSH BY "VIP" HILL		70	60	FAIR	LOW	1st	MUCH	ROCKS. GRASSY HILLSIDE. SURPRISE.	MODERATE
43	54637957	DRAGON AMBUSH BY "VIP" HILL		70	60	FAIR	LOW	1st	MUCH	ROCKS. GRASSY HILLSIDE. SURPRISE.	MODERATE
44	54627881	DRAGON AMBUSH E. OF CORRAL		60	50	GOOD	MED	1st	SOME	ROCKS. BRUSH. SURPRISE.	HARD
45	54527837	DRAGON AMBUSH S. OF CORRAL		60	50	GOOD	MED	1st	SOME	ROCKS. BRUSH. SURPRISE.	HARD
46	54577871	DRAGON AMBUSH E. OF CORRAL		60	50	GOOD	MED	1st	SOME	ROCKS. BRUSH. SURPRISE.	HARD
47	54427847	DRAGON AMBUSH W. OF CORRAL		60	50	GOOD	MED	1st	SOME	ROCKS. BRUSH. SURPRISE.	HARD
48	54367853	DRAGON AMBUSH W. OF CORRAL		60	50	GOOD	MED	1st	SOME	ROCKS. BRUSH. SURPRISE.	[illegible]

Inclosure b to Annex 3

OBSERVATION AND FIRE (SITE A)

1. INTRODUCTION. This inclosure contains a description of the relative observation and fire afforded the weapons that occupied the defensive positions on Site A during the Phase III trials (see table 21).

2. OBSERVATION AND FIRE. The following definitions pertain to the discussion contained herein. "Observation depends on conditions of terrain which permit a force to locate the enemy either visually or through the use of surveillance devices. The highest terrain in an area usually provides the best observation ... Fire, as used in the analysis of the Area of Operation ("Observation and Fire"), includes the field of fire of the weapon and characteristics of weapons delivery systems affected by weather and terrain ... A field of fire is an area that weapons can cover effectively with fire from given positions ... An ideal field of fire for flat trajectory weapons is an open area in which the enemy can be seen and on which he has no protection from the fire of such weapons."

3. CAVEAT. Intervisibility data is a prerequisite for playing engagement events in simulated battle trials. The information in this appendix is intended to supplement the intervisibility data collected during Phase I, particularly for those positions not examined in Phase I. This information is judgmental, however, the type of information provided herein was not readily derivable from the field data and so was developed to more fully describe trial conditions for input to the models. It was also applicable to those Phase I positions which were "improved" during subsequent TETAM phases.

4. Descriptive information on each position is tabulated in columns in table 21. The data in columns (1) through (5), (7) and (9) were developed based on recollection, study of Phase I intervisibility plots (limited to Phase I attack paths), and a study of photographs taken from positions 1 to 36 during Phase I of the experiment.

a. Position number. Positions are numbered as described in inclosure 1 to this annex; positions 1 to 36 correspond to Phase I panels, and all positions are arranged in decreasing order of their x-coordinates.

b. Left and right limit field of view (FOV). These are estimated azimuths to the left and right-most points in the target area that could be seen from this position.

c. Left and right sector limit. These are the estimated azimuths to the left and right-most points in the target area which were usually assigned by the platoon leader to weapons occupying the position.

d. Primary direction of fire (PDF). This is the estimate azimuth to the point within that weapon's sector of fire where the threat force was expected to first appear. It is intended to correspond to the most probably aiming point for that weapon at the start of the trial.

e. 3000 meters ATM coverage by fire of "battlefield," by quadrant. This is an assessment of the effectiveness of ATM coverage in each quadrant of the target area for a 3000 meter weapon occupying that position, except as indicated from DRAGON ("DGN"). The quadrants roughly correspond to the east and west threat approaches and lie beyond, and short of, a line 1500 meters from, and parallel to, the defensive terrain. The quadrants are defined as follows (see figure 15):

(1) SW-South of a line from 54207866 to 54657875 and west of a line from 54657875 to 55547816.

(2) NW-North of a line from 54207866 to 54657875 and west of a line from 54657875 to 54087950.

(3) SE-South of a line from 54657875 to 55547816 and east of a line from 54657875 to 55547816.

(5) NE-North of a line from 54657875 to 55757875 and east of a line from 54657875 to 54087950.

f. Intervisibility by range and approach route. This is an assessment of line-of-sight opportunities available to a force attacking on the western and eastern approach avenues of approach (see annex 2), at the indicated ranges, from any ATM occupying the position. This estimate differs from that of paragraph e (column 5) because it disregards ATM range capability and addresses line-of-sight relationships along attack paths at indicated ranges from the weapon. For example, an ATM in position 1 has "very poor" coverage in the NW quadrant (described in (5) above), but it has "much" intervisibility with the West approach at ranges greater than 3000 meters (see column 6).

g. Coverage in the vicinity of the "ruins." This is an assessment of the effectiveness of ATM coverage into the area founded by a line drawn from grid point 55187826 to 55647856 to 54687883 to 54507866. The area contains several low rocky hills, considerable vegetation and the ruins of the San Miguelito Ranch. It separates the east and west approaches to the defensive terrain, and is both an obstacle to rapid movement of the threat force and a source of cover and concealment of that force. The best defensive coverage of this area is generally provided by positions located off to the west side of the defensive ridgeline. Positions with sufficient elevation to observe down into this area can also cover it.

h. Elevation above target area (in meters). This is a measurement from a base of 1200 feet to the height of the position.

i. Vegetation in the foreground and target area. This is a judgmental description of the close-in vegetation in the immediate foreground of an ATM occupying this position. It also provides an estimate of the apparent vegetation (averaged over the entire target area) perceived from the position.

Table 21. Estimates of defensive observation coverage by fire and intervisibility (Site A positions)

POSITION #	OBSERVATION AND FIRE: LEFT LIMIT FOV	RIGHT LIMIT FOV	LEFT SEC LIMIT	RIGHT SEC LIMIT	PDF	3000 M ATM COVERAGE BY FIRE OF "BATTLEFIELD", BY QUADRANT: SW	NW	SE	NE	INTERVISIBILITY BY RANGE (BY GENERAL APPROACH ROUTE): WEST APPROACH > 3000	WEST APPROACH 1500-3000	WEST APPROACH < 1500	EAST APPROACH > 3000	EAST APPROACH 1500-3000	EAST APPROACH < 1500	COVERAGE VICINITY OF "RUINS"	ELEV ABOVE TGT AREA (M)	VEGETATION: FORE GROUND	TARGET AREA
1	281°	358°	281°	309°	301°	Fair	VP	Good	Good	Much	Fair	VP	Much	Good	Good	Fair	76	Low	Med
10	292	359	299	331	309	VP	Fair	Good	Good	Much	Poor	VP	Much	Good	Good	Fair	94	Med	Med
16	287	43	286	331	307	Fair	VG	Good	VG	None	VG	VP	Some	VG	Good	Poor	82	Med	Low
21	288	39	301	338	304	Fair	VG	VG	Good	Some	VG	VP	Some	VG	Good	VG	67	Low	Low
22	287	11	292	331	304	Fair	VG	Good	Good	None	VG	Poor	Some	Good	Good	VG	61	Low	Low
27	315	57	315	5	323	VP	Poor	Good	Good	None	VP	VP	None	Good	VG	Poor	49	Med	Low
28	310	37	310	10	325	Fair	Fair	Good	Good	None	Fair	Fair	None	Good	Good	Good	55	Med	Med
29	289	60	285	2	314	Good	Good	Good	Good	None	Good	Good	None	Good	VG	Good	37	Low	Low
30	293	18	298	350	322	Poor	Poor	Fair	Fair	None	VP	VP	None	Fair	Fair	Poor	27	Med	Med
33	304	317	307	318	311	Poor	Fair	VP	VP	None	Poor	Poor	None	VP	VP	VP	15	High	Med
35	298	72	299	312	306	Fair	Good*	Fair	Fair	None	Poor	Good	None	Fair	Fair	VP	24	High	Med
36	289	325	289	310	301	Good	Good	VP	VP	None	Poor	Good	None	Poor	VP	VP	18	Low	Med
37	267	79	293	350	299	Good	Fair*	VP	VP	None	VP	Good	None	VP	VP	Fair	0	Low	Med
38	298	61	316	12	373	Good	VP	VP	VP	None	VP	Good	None	VP	VP	Fair	-3	Low	Med
39	309	58	323	37	331	Good	VP	VP	VP	None	VP	Good	None	VP	VP	Fair	0	Low	Low
40	303	77	303	336	313	Good	VP	VP	VP	None	VP	Good	None	VP	VP	Fair	-3	Low	Low
41	318	77	331	18	354	Fair	Poor	Fair	Fair*	None	VP	Fair	None	Good	Fair	Good	12	Low	Med
42	117	218	162	261	242	VP	Good	VP	Good	None	None	Fair	None	None	Good	Poor	21	Low	Low
43	114	259	153	259	239	VP	Good	VP	Good	None	None	Fair	None	None	Good	Poor	30	Low	Low
44	202	101	215	323	295	VP	Good	VP	Good	None	None	Good	None	None	Good	None	6	Low	Low
45	307	101	340	75	351	Poor	Good	VP	Poor	None	None	Good	None	None	VP	Poor	0	Med	Low
46	199	27	219	330	303	VP	Good	VP	Fair	None	None	Good	None	None	Good	None	6	Low	Low
47	229	104	351	29	2	Poor	Good	VP	Fair	None	None	Good	None	None	Poor	Poor	6	Med	Low
48	312	113	355	42	6	Poor	Good	VP	Fair	None	None	Good	None	None	Poor	Poor	6	Med	Low
							(*DRAGON-POOR)												
1	2		3		4	5				6						7	8	9	

Annex 4 to Appendix A

TRIAL NARRATIVE

1. GENERAL COMMENTS ON TRIAL 96B (Site A: F&M). This trial is characterized by what was probably the best controlled attack of the Fire and Movement trials on Site A for either subphase IIIB or IIIE. The attackers apparently knew the site well, and made good use of available concealment. It was the third trial of the day on Site A for both forces. The previous two trials were minefield trials (Subphase IIIH) and the attackers probably had plenty of time to familiarize themselves with the terrain and defensive positions. Most of the attacking elements who did not initially have concealed approaches to the objective moved rapidly through the open areas until they reached the stream beds in the vicinity of hill 5 (see annex 2), where a considerable amount of concealment existed. Overwatch tactics were employed by two of the ATGMs without much success. TOW 19 was in what was probably the most difficult position on Site A to detect. It inflicted four of the eight attacker casualties without ever being fired upon. On the other hand, the Shillelagh was in the relatively exposed position it had occupied in the previous two trials, and it was the first defender to be engaged and the second to be killed. This trial had a somewhat lower than average percentage of unpaired firings (about 40%). Three of the five defenders were killed (both DRAGONs and the Shilelagh) and one of the TOWs did not fire (probably due to poor positioning). The attackers had one out of seven tanks, one ATGM, and all three ICVs surviving. The other two ATGMs had received mobility kills.

2. PREPARATIONS FOR THE CONDUCT OF THE EXPERIMENT.

a. Overview. By this trial, each force was well aware of its own capabilities, as well as those of the opposing force. The morale of the players was excellent, since this was the last trial for this particular group.

b. Preparation for the Attack.

(1) Probable factors affecting the attack plan. The attacker probably suspected the location of one of the DRAGONs and the Shillelagh, based on information gained during their two previous trials on this site earlier in the day.

(2) Special training/instructions - none recorded.

(3) Reconnaissance/activity in the assembly area - none recorded.

(4) Equipment/instrumentation/simulator supply. No exceptional information recorded.

c. Preparation for the Defense (reconstructed from platoon leader debriefing comments and the defense force controller's memory of instructions, discussions and circumstances at the time of trial).

(1) Special training/instructions. Crews were briefed by the platoon leader on the positions of the other ATM. With the exception of the TOW positions, they knew from previous use of similar positions the defensive coverage that could be achieved. The TOW positions were rather unique, with definite limitations in coverage. These limitations were not fully understood by the platoon leader before the trial and were certainly not known to the Shillelagh and DRAGON crews. The platoon leader beirfed his defensive concept to the crews before deployment and gave them their sectors and open fire ranges. He did not emplace each weapon himself, however.

(2) General formulation of defense plan. All positions were on the western end of the defensive terrain. The platoon leader attempted to conceal his defense from the attackers by choosing infrequently used positions for his TOWs. These positions were better concealed than the positions used earlier in the day, but offered less coverage of the battlefield. He, therefore, left the Shillelagh in the exposed position from which it had maximum coverage and had enjoyed some success in the two preceding trials that day. The DRAGONs were placed well forward on the west side, where the platoon leader expected the greatest threat.

(3) Selection of positions. The defense force platoon leader expressed his concept generally as follows:

(a) "The enemy has knowledge of our favored ATM positions. Therefore I want TOW 18 concealed in position 27, covering the eastern approach and TOW 19 in position 33, covering the western approach. These positions are back in the trees, infrequently used, and probably not anticipated by the enemy. TOW coverage will be somewhat restricted, so I want Shillelagh in position 29, from which it operated successfully in previous battles. Use the dugout position for cover in hull defilade. Although the TOW in position 33 covers the western approach, it is limited to long range targets. I want both DRAGONs covering this dead space in TOW coverage on the western avenue of approach.

(b) "I do not want control measures to delay the engagement of long range targets. Therefore, call for clearance to fire on the first available in-range target, then fire at will. Keep me posted on results. I will monitor and designate targets to insure none are missed.

(c) "I will position myself near the Shillelagh (21) so I have maximum observation and can warn of targets about to appear in our zone and designate targets before they actually come into your view. Watch out for SAGGERs in overwatch as the enemy first appears. Try to get the tanks before they come in range of their main gun.

(d) "Remember this is our last day and we do not want the tankers lording this over us back at Fort Hood."

3. TRIAL EXECUTION.

a. Conduct of the Attack.

(1) *General description of the attack as implemented.* The three platoons crossed the LD at about 1355 hours. The left platoon entered the initial killing zone hear hill 1284 at about 1358, and the center platoon and left platoons about a minute later. Tank 1 followed the center platoon into the killing zone and set up behind the corral, where it appeared to be either observing the attack or assuming overwatch role. Tank 8 and ATGM 11 were killed almost immediately, and Tank 1 then fired at the Shillelagh. By this time (1400) the attacker force was in a company line with tanks roughly on line, ATGMs and ICVs following. The two left platoons moved rapidly through the killing zone. The right platoon appears to have reached a concealed area at about 1401 and started supporting the left and center platoons by fire, with Tank 9 and the ATGM assuming an overwatch role, and Tank 5 firing from a short halt. The left platoon entered the concealed area about 1000 meters in front of the objective at about 1402. With the exception of the ICV, the center platoon had been destroyed by this time. The left and right platoon survivors spent the next three minutes firing at the defenders, and, perhaps, reorganizing. At about 1405 Tank 7 and ICVs 14 and 15 assaulted the objective. All survived, arriving at the TTL at about 1409. Tank 7 had fired occasionally, apparently from the short halt. Tank 5 also assaulted at 1405 and was killed as he traversed the killing zone northwest of the DRAGON positions. Tank 9 tried the same approach about four minutes later, after he had killed the remaining DRAGON, but suffered the same fate. ATGM 12 was moving slowly to the objective, probably in a concealed area, when the trial terminated.

(a) Movement to contact. The attackers moved from the assembly area to the LD on two routes, in column formation. The right column separated after crossing the LD and just prior to entering the initial killing zones. The attacking force altered its direction of attack toward the southeast. The attackers started sustaining casualties shortly after they entered the initial killing zones.

(b) Actions when engaged. The attackers, with the exception of Tank 1, continued to advance rapidly through the killing zones toward the areas where some cover and concealment existed. Once in these areas, the attackers took the defenders under fire. The surviving tanks generally fired one or two rounds, probably from a short halt. The surviving ATGM appeared to be employing the overwatch tactic to cover the movement of the tanks toward the objective.

(c) Initial engagements. Two attackers, Tank 8 and ATGM 11, had been killed by the time the first attacker round was fired. Tank 1 then fired at the Shillelagh at a range of about 2150 meters. About 30 seconds later, both Tank 2 and Tank 5 fired (unpaired). These engagements may have been with the Shillelagh, who had inflicted the mobility kill on ATGM 11, and who then killed Tank 2 at a range of about 1750 meters. The first ATGM engagement was by ATGM 12 against the Shillelagh, at a range of about 1800 meters. The defenders survived all the initial engagements.

(d) Subsequent engagements. ATGM 12 fired four more rounds at the Shillelagh, killing it on the fifth round. The tanks continued to fire and move, generally firing one or two rounds at a time, most of which were unpaired. Tank 9 was the exception, firing 10 unpaired rounds from what must be considered an overwatch position in the vicinity of coordinates 554785. Tank 3 also appeared to have assumed an overwatch mission, firing five rounds at DRAGON 24. Both these tanks may actually have made a definite detection of a defender weapon(s) within their (the tanks) known effective range and continued to fire at them until the defenders were killed. Thus they may not deliberately have assumed an overwatch role, but were actually being very persistent.

(e) Other.

1. Prior information. It is likely that the attackers suspected the location of both Shillelagh 21 and DRAGON 24. DRAGON 24 occupied a very commonly used position and was engaged and killed before it had fired a round. Shillelagh 21 occupied the same position it used in the previous two trials that day. The Shillelagh was the first defender engaged. This prior knowledge probably explains why Tank 1 proceeded directly to an overwatch position and began engaging the Shillelagh so early in the trial.

2. Average speed. The average speed of the left platoon was reduced below the average for the company shortly after the attackers crossed the LD. It is not clear whether this was intentional (i.e., a phase line existed) or was a result of difficulty in crossing a dirt road in this area.

3. Unpaired firings. An analysis of the defensive overlay shows that two of the artillery simulator positions were located within a few hundred meters of defender weapons (annex 5). This may explain some of the attacker unpaired firings (i.e., they may have been firing at the simulators).

4. ICV maneuver. ICV 13 moved across the battlefield directly in front of the defender positions prior to crossing the TTL. This anomalous behavior had no apparent effect on the trial.

5. Ammunition supply/reload. ATGM 10 fired five rounds at the Shillelagh in about 130 seconds from an average range of 1700 meters. The longest time lag between rounds was about 50 seconds. The time between the fourth and fifth round was 26 seconds. Thus, it does not appear that the reload-time delay of 90 seconds after the fourth round was played for this weapon. The ATGMs who were firing had three rounds each remaining at the end of the battle.

6. Trial termination line (TTL). Tank 5 was killed short of the TTL and this may have decoyed Tank 9 into thinking he was in a safe area, since Tank 9 probably arrived after Tank 5's smoke grenade burned out. All other signs (turret turned to the reat, panel showing) would indicate successful arrival at the TTL located in this area.

(f) Summary. The Shillelagh was definitely the center of attraction for the attackers in this battle, with the DRAGONs next. It is remarkable that the Shillelagh survived as long as it did considering the number of shots directed at it and the killed probabilities involved. It is likely that neither TOW was seen by the attackers, even though TOW 19 was the biggest killer in the trial, having killed four attackers with five rounds. Probably the most important effect in this battle was the apparent knowledge that the attackers had of the battle area. They did not make the mistakes observed so often in other trials, where the attackers stopped and fired from exposed positions as they were engaged, or assumed an overwatch role outside the effective ranges of their weapons.

b. Actual Conduct of the Defense.

(1) General description of the defense as implemented. See paragraph 3c above.

(2) Initial engagements. TOW 19 fired the initial round of the battle, killing tank 8 at a range of about 2400 meters. The first Shillelagh round was fired at ATGM 10 at a range of about 2050 meters, resulting in a mobility kill. DRAGON 23 opened fire at ICV 15 at a range of 800 meters. The ICV survived. TOW 18 and DRAGON 24 did not fire in this trial.

(3) Subsequent engagements. The Shillelagh fired the third defender round at Tank 2, inflicting a mobility kill at a range of about 1750 meters. TOW 19 then fired two rounds at Tank 1 at a range of 1850 and 1700 meters, respectively. The second round resulted in a total kill. Thus, 40 percent of the attacker's firepower capability was eliminated by the first five defender rounds. These engagements took place over a two minute period at ranges outside of the effective range of the tank main guns.

(4) Other.

1. Target selection. The initial target selection process for the TOW and Shillelagh appears to have been to engage the attacker tanks and ATGMs as they came into range and view, regardless of the attacker weapon type. ICVs were ignored as usual.

2. Ammunition supply/reload. The Shillelagh did not engage targets within the range of its conventional rounds (800 meters). However, the firing data shows it to have fired eleven missiles, even though it had a basic load of only 10.

Ammunition Expenditures

	Basic Load	Rounds Fired	Rounds Remaining
TOW 18	10 missiles	0	10
TOW 19	10 missiles	5	5
Shillelagh 21	10/19	11/0	-1?/19
DRAGON 23	6	4	2
DRAGON 24	6	0	6

3. Rate of fire. After the first six rounds were fired at a rate of two per minute, the defender's firings dropped off markedly. Only eight more rounds were fired by the defenders during the remaining 10 minutes of the battle. The latter firings resulted in three total kills (Tanks 3, 5, and 9) and a mobility kill on ATGM 10. During this period two defender weapons (Shillelagh and DRAGON 23) were killed.

4. Maneuver. The defender weapons did not appear to have moved during this trial.

Inclosure a to Annex 4

Sequence of Significant Events, Trial 96

1352 Start of trial

1355 Attackers cross LD

1358 Attackers entered initial killing zone

1359 TOW 19 killed Tank 8 (1st engagement of trial)

1400 TOW 19 fired at Tank 1

Shillelagh 21 killed (mobility only) ATGM 11

Tank 1 fired at Shillelagh 21

Tank 5 fired two rounds (unpaired) from a short halt

ATGM 12 entered overwatch position and commenced firing at Shillelagh 21

Shillelagh 21 killed Tank 2 after the tank had fired one round (impaired)

1401 Tank 1 fired (unpaired)

TOW 19 killed Tank 1

Tank 5 fired two rounds from another short halt

1402 Tank 3 entered O/W position, commenced firing at DRAGON 24

Tank 9 entered O/W and commenced firing (ten unpaired firings over next 3 minutes)

1403 ATGM 10 entered O/W position and commenced firing at Shillelagh 21

Tank 7 fired two rounds from a short halt

ATGM 10 received mobility kill from Shillelagh 21

1404 DRAGON 24 killed by Tank 3

1405 Tank 3 killed by DRAGON 23

ATGM 12 killed Shillelagh 21

Tanks 9, 5, and 7, ATGM 12, and ICVs started moving out together

Tank 7 and ICVs 14 and 15 entered intermittently vegetated area

1406 Tank 7 fired two rounds from a short halt while moving to the TTL

1408 Tanks 5 and 9 entered close-in killing zone

DRAGON 23 killed by Tank 9

Tank 5 killed by TOW 19

Tank 7 fired one round and crossed TTL

ICV 13 crossed killing zone

1409 ICV 15 and 15 cross TTL

1410 Tank 9 killed by TOW 19

ICV 14 crossed TTL

1412 End of trial, ATGM 12 still moving slowly toward TTL

Annex 5 to Appendix A

Attacker Company E
Site A
5 December 1973

OPORD 96A
Ref: Map, ALDER PEAK, CA, 1:25,000
Sheet 1755 IV NW

Task Organization

CO Con Tank 1	1st Plt: Tanks 7**,3; ATGM 10*; ICV 14
2d Plt Tanks 2**, 8; ATGM 11*, ICV 15	3d Plt: Tanks 9**, 5; ATGM 12*, ICV 13

** Platoon Leader
* Section Leader

1. Situation.

a. Enemy Forces. It is likely that the attackers suspected the location of both Shillelagh 21 and DRAGON 24.

b. Friendly Forces. NA

2. Mission. Company E attacker at 051355 December 1973 to destroy the defender force and/or reach the Trial Termination Line, using a Fire and Movement tactic.

3. Execution.

a. Concept of Operation.

(1) Maneuver. Company E attacked to the Southeast, three platoons abreast using primarily Avenue of Approach #1. The tank sections of each platoon led the attack, 1st platoon on the left, 2d platoon in the center, and 3d platoon on the right. One ATGM and one ICV followed each platoon, maneuverind independently after contact was made with the defender.

(2) Fires. The tanks generally fired one or two rounds from the short halt. The ATGM entered concealed positions and assumed the overwatch role, concentrating their fires on the Shillelagh. Tanks 1 and 9 operated in a manner similar to the ATGM.

c. Coordinating Instructions:

(1) Position Locations	CO	1st Plt	2d Plt	3d Plt
(a) Maneuver Unit	1	2	3	4

	CO	1st Plt	2d Plt	3d Plt
(b) Players	1	7,3;11,14	2,8;11,15	9,5;12,13
(c) Route to LD	53058085 53518053	53068086 53508055	53028086 -	53058082 -
(d) LD Crossing Pt	53658028	53668027	53427977	53427977
(e) Phase Line 1	53577983	53617983	-	-
(f) Direction of Attack from LD/Phase Line 1	53627964	53847973 54157931	53627964 53827928	53527932 53667912
(g) O/W Psn #1 O/W Psn #2	54257879 NA	54817861 NA	NA* NA	54117879 54427851 (tanks only)
(h) Phase Line 2 (F&M from here to obj)	NA	54937864	54607860*	54427850
(i) TTL Crossing Point	NA	55377830	55207830*	54987822*

*Projected

(2) Coordination of Fires	Tanks	ATGM
(a) Open Fire Range	2150m	1850m
(b) Sector of Fire (around direction of movement)	60^o	60^o
(c) Number of Rnds/Tgt (before selecting another target)	5	5

d. Actions/Speeds at Phase Lines.

(1) LD: The right and center platoons separated and changed direction at the LD (a stream bed). There was some slowdown in the movement of all the vehicles, probably as a result of entering the streambed.

(2) Phase Line 1. Phase Line 1 was a dirt road perpendicular to the 1st platoon's direction of movement from the LD. The lead vehicle apparently waited about a minute for the rest of the platoon to catch up before changing direction and attacking to the southeast.

(3) Phase Line 2. The attackers had been significantly disrupted by fires from the defensive positions and appeared to have reorganized at the 2d phase line.

e. Order of Arrival at TTL.

	Time	Attacker
(1)	1408	Tank 7
		ICV 15
(2)	1409	ICV 14
(3)	1410	ICV 13

f. Times.

(1) SP time: 051352 December 1973.

(2) LD time: 051355 December 1973.

(3) Phase Line 1. 051358 December 1973. H + _____

(4) Phase Line 2. 051405 December 1973. N + _____

(5) Trial Termination Line. 051412 December 1973. H + _____

4. Administration and Logistics.

a. Basic Loads. (Tanks 1, 2, 5, 7, and 9 did not have functioning flash-bang simulators in this trial.)

(1) Tanks: 40 rounds APDS/Heat

(2) ATGM: 12 rounds

b. Reload Time.

(1) Tanks: 3 seconds (CIP), see classified annex

(2) ATGM: 1½ minutes reload time after four missiles fired. (Not adhered to in this trial.)

5. Command and Signal.

a. Signal: All attackers were on the same frequency.

b. Command: Omitted.

Element	ASSEMBLY AREA TO LD*			LD TO PHASE LINE 1			LD (PHASE LINE 1) TO OVERWATCH PSN (PHASE LINE 2)			PHASE LINE 2 TO TTL		
	Type	Org	Ave Spd	Type	Org	Ave Spd	Type	Org	Ave Spd	Type	Org	Ave Spd
(1) CO Tank 1	Follow 1st Plt	7 350m 1	5.5 m/s	Follow 1st Plt	7 350m 1	5.5 m/s	Follow 2d Plt	2 120m 1	5.0 m/s	Remain in place?		
(2) 1st Plt	Plt Col	7 140m 3 100m 10 20m 14	5.4 m/s	Plt Col	7 140m 3 100m 10 20m 14	7.2 m/s	?	120 7 3 320m 10 60m 14 30m	5.6 m/s	Line	180m 7 3 60m 14 60m	3.7 m/s
(3) 2d Plt	Plt Col	2 240m 8 140m 15 60m 11	5.5m/s		N/A			30m 50m 2 8 11 40m	3.9m/s	Line	100m 2 8 60m 15 120m	3.5m/s
(4) 3d Plt	Plt Col	9 150m 5 12 50m 13	5.7m/s		N/A		Plt Col	9 100m 5 60m 12 10m 13	3.9m/s	Col ?	300m 13 5 300m 9	3.4m/s

Annex 6 to Appendix A

Defender Group 6
Site A
5 December 1973

OPORD 96D
Ref: Map, ALDER PEAK, CA, 1:25,000
Sheet 1755 IV NW

Task Organization

Short Range ATM Section
DRAGON 23
DRAGON 24

Long Range ATM Section
TOW 18
TOW 19
Shillelagh 21

1. Situation.

a. Enemy Forces. Omitted

b. Friendly Forces. Artillery simulators (spoofers?) were located at

(1) 56637766

(2) 56377776

(3) 55967788

(4) 55587790

(5) 55357828

(6) 55087803

2. Mission. The platoon implemented a deliberate defense from 5495877974 to 5586777794 by 051353 December 1973.

3. Execution.

a. Concept of Operation

(1) Maneuver: NA

(2) Fires: The platoon elements concentrated their fires on the left side of their assigned sectors of fire.

b. Position Data: (See Position Analysis, Annex ___)

	ATM	Posn #	Coordinates	PDF	%Uncov	%Uncon
(1)	TOW 18	27	5586777794	323°	60	50
(2)	TOW 19	33	5555677729	311°	100	80
(3)	Shillelagh 21	29	5569277879	314°	40	40
(4)	DRAGON 23	38	5500578093	306°	80	50
(5)	DRAGON 24	41	5495877974	354°	100	70

c. Coordinating Instructions

(1) Sectors of Fire

ATM	Left Sector Limit	Right Sector Limit
(a) TOW 18	315°	5°
(b) TOW 19	307°	318°
(c) Shill 21	285°	2°
(d) DRAGON 23	316°	12°
(e) DRAGON 24	331°	18°

(2) Control of Fires

(a) ATMs were to request clearance to fire on the first available target that came within range.

(b) Subsequent targets were fired upon at will.

(c) The defense net was monitored for targets spotted by PL and designated for a specific ATM.

(3) Planned target priority:

(a) At long range (over 1500m):

1 SAGGER
2 T62
3 ICV

At short range (less than 1500m):

1 T62
2 SAGGER
3 ICV

(b) Exceptions: Consideration was to be given to engagement of attacker weapons observed to be engaging (1) Self or (2) other friendly ATM, based on actions noted; i.e., stopped, tube pointing in direction of self or other friendly element (with or without firing signature simulator cue).

(c) Engagement of ICVs was last priority, i.e., when no other targets were available.

(d) ATMs were to engage targets in sector first, then targets in other ATM sectors, when multiple targets of equal threat were intervisible.

(4) Number of rounds per target. After two rounds consideration was given to switching to other available targets. If no other targets were in view, consideration was to be given to firing a third round at the same target. Firing was then to be stopped in order to save ammo for later targets and to minimize the effect of possible instrumentation difficulties or other reasons for lack of success.

(5) Control by Platoon Leader. The platoon leader attempted to:

(a) Spot targets and designate, by radio, specific ATM for engagement.

(b) Designate targets about to come into view for a specific ATM.

(c) Designate targets to minimize duplication.

(6) Other Instructions. The defenders were instructed to:

(a) Report targets spotted that could not be engaged (for PL to assign to other weapons).

(b) Inform PL when only 2-3 rounds remained, and when ammunition was depleted.

(c) Camouflage positions and prepare range cards with sectors, PDF and reference points at known ranges, as provided by PL. If time was limited, they were to camouflage positions and use PL instructions ILO prepared range cards to control fires.

(7) Open Fire Ranges

(a) TOWS: 3000 meters
(b) Shillelagh: 3000 meters
(c) DRAGON. 1000 meters

d. **TOW 18: Cover sector.** Engage targets along East side of platoon zone.

e. **TOW 19: Cover sector.** Engage targets in open area beyond Corral and along road.

f. **Shillelagh 21: Cover sector.** Prepared to augment defender ATM coverage anywhere in field of view.

g. DRAGON 23. Cover sector. Covered open area short of Corral.

h. DRAGON 24. Cover sector. Augmented fires of DRAGON 23 and was to engage targets flanking DRAGON 23 east of the hardtop road.

4. Administration and Logistics

a. Logistics

(1) Basic Loads
(a) TOW. 10 missiles
(b) Shillelagh: 10 missile, 19 conventional
(c) DRAGON: 6 missiles

b. Administration

(1) Reload Time
(a) TOW
(b) Shillelagh
(c) DRAGON

(2) Ammunition Crossover Range, Shillelagh: 800 meters

5. Command and Signal

a. Signal. All members of the platoon monitored the defender net. The vehicle commanders, section leaders and platoon leader could transmit.

b. Command. The platoon leader was probably located in the vicinity of the Shillelagh (vic 557779).

BIBLIOGRAPHY

BIBLIOGRAPHY

Anderson, Edward G. Analysis of the Area of Operations (Site A-TETAM). Unpublished special study project. USACACDA, Fort Leavenworth, Kansas 66027, undated.

BDM Services Company. TETAM Extended Analysis. P.O. Box 456, Leavenworth, Kansas 66027, December 1974.

Bishop, Albert, and Gordon Clark. The Tank Weapon System. AR 69-2a and AR 69-2b. Systems Research Group, Department of Industrial and Systems Engineering, The Ohio State University, Columbus, Ohio 43210, 1969.

Hickey, John D. Description and Analysis of Defensive Positions (TETAM). Unpublished special study project. USACACDA, Fort Leavenworth, Kansas 66027, undated.

Murdick, R. G., and J. E. Ross. Information Systems for Modern Management. Prentice Hall, Englewood Cliffs, N.J., 1971.

Naylor, Thomas H. et al. Computer Simulation Technique. John Wiley & Sons Inc., New York, 1966.

Smith, R. E. et al. TETAM Effectiveness Evaluation. TM 2-73. Combat Operations Analysis Directorate, Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, 16 November 1973.

Statz, John R., Jr., and Elizabeth Etheridge. Personnel and Training in Battalion-Level Force Models. Technical Report 10-76. US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, October 1976.

US Army Combat Developments Experimentation Command. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report. CDEC Experiment 11.8, Volumes VIII and IX. Fort Ord, California 93941, February 1974.

US Army Combined Arms Combat Developments Activity. TETAM Model Verification Study. Technical Report 6-76. Volume III, Dynamic Battle Comparisons. Fort Leavenworth, Kansas 66027, February 1976.

US Army TRADOC (ATCD-AN-C). Model Improvement Program. Letter, 9 December 1977.

CITED REFERENCES

1. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974.

2. The Tank Weapon System. Bishop, Albert, and Gordon Clarke. AR 69-2a and AR 69-2b. Systems Research Group, Department of Industrial and Systems Engineering, The Ohio State University, Columbus, Ohio 43210, 1969.

3. Personnel and Training in Battalion-Level Force Models. Statz, John R., Jr., and Elizabeth Etheridge. Technical Report 10-76. US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, October 1976. pp 2-4

4. TETAM Model Verification Study. Volume III, Dynamic Battle Comparisons. Technical Report 6-76. US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, February 1976.

5. Model Improvement Program. Letter, US Army TRADOC (ANCD-AN-C), 9 December 1977.

6. Personnel and Training in Battalion-Level Force Models. Statz, John R., Jr., and Elizabeth Etheridge. Technical Report 10-76. US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, October 1976. p 13

7. Information Systems for Modern Management. Murdick, R. G., and J. E. Ross. Prentice Hall, Englewood Cliffs, N.J., 1971.

8. Personnel and Training in Battalion-Level Force Models. Statz, John R., Jr., and Elizabeth Etheridge. Technical Report 10-76. US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, October 1976. pp 2-4

9. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol VIII, p C-2-A-9

10. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol VIII, p C-2-13

11. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol IX, Appendix 1, Trial 96

12. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol IX, p B-2-31

13. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol IX, Appendix C, Trial 96

14. TETAM Effectiveness Evaluation. Smith, R. E. et al. TM 2-73. Combat Operations Analysis Directorate, Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, 16 November 1973.

15. TETAM Extended Analysis. BDM Services Company, P.O. Box 456, Leavenworth, Kansas 66048, December 1974.

16. The Tank Weapon System. Bishop, Albert, and Gordon Clark. AR 69-2a and AR 69-2b. Systems Research Group, Department of Industrial and Systems Engineering, The Ohio State University, Columbus, Ohio 43210, 1969.

17. Analysis of the Area of Operation (Site A-TETAM). Unpublished special study project. USACACDA, Fort Leavenworth, Kansas 66027, undated.

18. Description and Analysis of Defensive Positions (TETAM). Hickey, John D. Unpublished special study project. USACACDA, Fort Leavenworth, Kansas 66027, undated.

19. Tactical Effectiveness Testing of Antitank Missiles (TETAM). Final Report, CDEC Experiment 11.8, Volumes VIII and IX. US Army Combat Developments Experimentation Command, Fort Ord, California 93941, February 1974. Vol VIII, Appendix B.