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**MEASUREMENT OF
COMBAT EFFECTIVENESS
IN
MARINE CORPS
INFANTRY BATTALIONS**

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EXECUTIVE SUMMARY

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**Inquiries and comments on this report should be
addressed to:**

Dr. Robert Young
Director, Cybernetics Technology Office
Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209

LtCol Roy Gulick
Program Manager
Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209

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**MEASUREMENT OF
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EXECUTIVE SUMMARY

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10 Richard E. Hayes

Cybernetics Technology Office
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PREFACE

The research team wishes to acknowledge the generous cooperation and support received from a number of individuals and organizations. The Cybernetics Technology Office of the Defense Advanced Research Projects Agency, which has a major interest in the area of combat effectiveness and combat readiness, sponsored these analyses. LtCol Roy Gulick of that office, program manager for the effort, contributed valuable guidance and suggestions to the research project.

The Contracting Officer's Technical Representative, Col Richard J. Johnson of the Evaluation Team, Readiness Branch, Operations Division of Headquarters Marine Corps, performed admirably in his role. His willingness and ability to act as effective liaison for the project with offices and organizations throughout the Washington, D.C., area and the Marine Corps were an invaluable asset. His prompt, thorough review of drafts, willingness to challenge, probe, and question, capability for sharing his experience and insights, and high standards of performance were of exceptional help to the effort. Col Battistone was most generous in his willingness to allow Col Johnson to involve the considerable talents of the Readiness Branch in the project.

The research effort would have been nearly impossible if it had not been for the excellent professional assistance received from the Marine Corps Historical Center. Brigadier General E.H. Simmons, Director of the Center, took a personal interest in the project and ensured that the fine new research facilities there were available to the study team even before they were formally open to the public. Mr. Henry I. (Bud) Shaw was very generous with his time and energy. His first-hand knowledge of the available historical materials is tremendously impressive. His willingness to share his knowledge and insights saved the research team a tremendous amount of time. Ms. Bonnet, the Archives Secretary, was an

effective professional who tolerated massive intrusion into her limited space with cheerfulness and genuine goodwill.

Cooperation from the officers and commands within the Marine Corps was exceptional. A visit by the principal investigator to the base at Twenty-nine Palms, California, was particularly valuable. The personnel at the Marine Corps Air-Ground Combat Training Center (MCAGCTC) demonstrated effective professionalism, not only in the conduct of exercises, but also in their ability to explain, clearly and in detail, the rationale and procedures that they utilize. The hospitality of the officers and enlisted personnel in that command was genuine and is greatly appreciated.

A visit to the Naval War College at Newport, Rhode Island, was characterized by similar hospitality, interest, and helpfulness. The President of the College, Admiral Huntington Hardisty, and particularly Col William Weise, Senior Marine Corps Representative on the faculty there, who took a personal interest in the project, were most gracious in allowing the use of their facilities for data collection.

In addition, a special word of thanks is due to all the Marine Corps officers, active duty and retired, who contributed their time and energy to the data coding. The professionalism they displayed added significantly to the content of the study. Long hours of concentration and hard work were cheerfully given by all concerned; officer/students at the Naval War College, retired officers, officers awaiting school assignment, and volunteers from Headquarters Marine Corps. Without help from these people, the research could not have been completed. Their contributions have made possible whatever value the analyses produce. They are not, of course, responsible for errors committed by the research team.

A number of different CACI staff members contributed to this project. The principal investigator was Dr. Richard E. Hayes, Manager of the

Policy Sciences Division. Military experience and expertise were provided by MG John J. Hayes, USA(Ret) and Dr. Paul Davis (COL, USA(Ret)). Construction of narratives was supported by Messrs. Gary Keynon and William Harvey. Help with questionnaire construction was provided by Drs. Bertram Spector and David McCormick. Mr. Harvey took primary responsibility for assembling the data set and initial selection of statistical approaches. Dr. Farid Abolfathi carried out most of the detailed, multivariate analyses.

The massive task of producing the paper necessary for the effort was handled with high professionalism by the Policy Sciences support staff led by Ms. Nancy Streeter and Ms. Donna Goodyear. The typing was cheerfully and quickly completed by April Bailey, Lisa Dueno, Kathy Harris, and Jessica Johnson.

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BACKGROUND

One of the most crucial problems facing military commanders and defense decision-makers is the maintenance of an "effective" military capability. Creating combat-ready units in time of war, establishing standards and priorities for training, procuring, and staffing during periods of relative peace, and assuring a military capability that deters potential adversaries from dangerous adventures have long been central missions of the U.S. armed forces. Yet, measuring "military effectiveness" without data from combat experience remains a major unresolved research problem.

Military operations are complex undertakings involving a variety of social processes (such as C³, planning, and so forth), physical movements, mechanical operations, and rapidly changing situations about which knowledge is always incomplete. These have traditionally been described in terms of functional areas -- command, operations, logistics, intelligence, and so forth. The failure of any one functional area may undermine the performance of a unit. But military effectiveness is more than the sum of its functional parts. All functional aspects of an operation may go well, but a unit may still fail to accomplish its mission. Conversely, history is replete with examples of military units that achieved their missions despite functional failures.

The U.S. military has long recognized this and has therefore made commanders responsible not for mere technical proficiency within their units but for effective performance. Units that have fewer functional failures, overcome obstacles, and achieve their objectives are viewed as "successful." Focus is placed on outcomes -- the achievement of desired goals -- rather than the process involved in getting there. In short, military effectiveness can only be measured in terms of mission

accomplishment. The research reported here was sponsored by the Cybernetics Technology Office of the Defense Advanced Research Projects Agency (ARPA/CTO) to determine whether a research methodology based on this principle could be developed and implemented.

OBJECTIVES

↳ The research reported in this volume had three major objectives:

- (1) Improved understanding of the concept of combat effectiveness.
- (2) Development of algorithms (procedures) for projecting combat effectiveness, *and*
- (3) Exploration of the implications of combat effectiveness for readiness.

As used in this report, the concept "combat effectiveness" refers to the ability of a unit to accomplish a military mission. As such, combat effectiveness refers to performance in a hostile environment, as distinguished from the concept of "readiness," which refers to a state of preparedness prior to entering the hostile environment. ↗

As discussed in the body of the report, there has been virtually no systematic, empirical research into the "combat effectiveness" of units. To a large extent, this lack of research has been due to an inability to create an empirical measure of combat effectiveness -- a replicable, valid, coherent scale against which unit performance can be reliably gauged. Hence, the development of such a scale and the resulting improved understanding of the concept of combat effectiveness were the first goals of the research effort.

Given the ability to scale unit performance, it was then possible to examine associations between "effectiveness" and other variables -- attributes of units, levels of performance, enemy capabilities, and so

forth. Using research techniques that blended the judgment of experienced officers with empirical evidence, the research team was able to create algorithms reflecting these associations. These algorithms, in turn, have implications for

- Procurement decisions,
- Allocation of training time,
- Research priorities,
- Unit composition, and
- Development of doctrine.

In addition, a particular effort was made to focus on the combat readiness implications of the research. Specifically, three concerns were examined:

1. To what extent can the research be used to find ways of projecting combat effectiveness before a unit is deployed in a potentially hostile environment?
2. To what extent can research be used to evaluate exercise performance as an indication of future combat effectiveness?
3. To what extent does the research validate existing systems for measuring combat readiness or suggest innovations in readiness measurement?

FOCUS

These objectives are ambitious. During the initial phase, research focused on U.S. Marine Corps infantry battalions engaged in offensive operations. Marine Corps units were selected because

- The Commandant of the Marine Corps has a strong interest in the subject of combat readiness, as is evidenced

by the recent development of the Marine Corps Combat Readiness Evaluation System (MCCRES) by Marine Corps personnel.

- Headquarters Marine Corps provided assistance in the form of an experienced officer to serve as the Contracting Officer's Technical Representative (COTR) for the study.
- Outstanding facilities of the U.S. Marine Corps Historical Branch and Library were available to support the data collection effort.

At the same time, every effort was made to ensure that the research was not focused exclusively on the Marine Corps, but on the general issues of ground combat. This is intended to facilitate application of the findings and, where appropriate, broadening of the research effort.

Infantry battalions were examined because they are the single most numerous maneuver units, and because battalions are the smallest units for which accurate data are likely to be found. The lowest level of analysis practical was desired in order to ensure focus on combat -- interaction with hostile forces. At the same time, data were collected on the activities of higher headquarters and supporting elements as their actions impacted on the infantry battalions being studied.

Focus was limited to offensive operations for two reasons:

1. Some substantive focus was necessary to produce a coherent data set for analysis within the limited resources available.
2. Offensive operations are among the most frequent and important undertaken by U.S. military units and are emphasized in current doctrine.

Specific military operations, usually confined to a few days, comprised the units of analysis. Twenty-two cases from four combat eras were examined -- World War II (10 cases), Korea (5 cases), Vietnam (5 cases), and

special operations (2 cases; Dominican Republic and the 1958 Lebanon landings). Cases were chosen to provide a variety of experience.

APPROACH

The research approach was to tap the judgment of officers with combat experience. Rather than asking officers to list the factors which they believed to be most important in determining combat effectiveness, however, the study team wanted to create a "context." These contexts consisted of brief (8-21 pages) narrative descriptions of specific engagements. There were three reasons for using this format:

- Other researchers have in the past, and are today, using survey instruments to gather the abstract opinions of experienced officers on this topic. Differences between their findings and ours may provide important insights.
- Collection of opinions in the abstract has a strong tendency to reproduce doctrine -- officer's opinions are shaped by training as well as experience, and the training is often more recent.
- Use of historical cases allows cross-checking of officer opinion with the historical information available.

The officer participants were asked, based on their readings of the narratives, to provide information on three issues:

1. Did the unit accomplish its mission?
2. Compared with other cases, how well did the unit accomplish its mission?
3. Why did the unit succeed or fail -- what were the crucial factors that contributed to the unit's relative level of mission accomplishment?

These "judgmental" data were supported by "historical" information coded by the project team. Historical data were collected for factual issues

(how many personnel were in the unit, what were their levels of experience, and so forth) or those that required detailed examination of historical records (maintenance problems encountered, availability of specific types of ammunition, and so forth).

RESEARCH RESULTS

INTRODUCTION

There are four major topics covered in this section. The first is a review of the statistical and substantive limitations of the research completed to date and a list of the Phase II analyses (underway) designed to overcome these limitations. The other three sections report findings (a) based on the factors identified as crucial determinants of combat outcomes by officer participants, (b) based on the historical data, and (c) focused on the problem of evaluating field exercises.

CAVEATS -- LIMITATIONS ON THE FINDINGS

No research effort can have universal application. Indeed, well-designed research is usually narrowly focused to reduce the number of confounding variables present, allow greater confidence that the findings are meaningful, and to increase understanding of the processes at work.

The major substantive limitations of the analyses presented below can be summarized in two main points:

1. The data are historical, not focused on the future. Hence, characteristics of the future battlefield are either underrepresented or not present at all in the data set.
2. The focus is on Marine Corps infantry battalions in offensive missions. Extension to other types of units, levels of command, services, or classes of mission can only be made with great caution.

From a statistical standpoint, the reader must understand five principal limitations on the interpretation of the analyses.

- The analyses are cross-sectional, not over time. To be truly valid, the findings should be tested by observing the same units over time.
- The analyses are limited by the historical record available. Neither the narrative descriptions nor the objective data collected by the study team are complete or perfectly accurate.
- The absence of findings regarding a variable indicates that no evidence was found indicating that the variable was systematically associated with changes (variance) in levels of combat performance.
- Statistically, 22 cases is a very small number with which to work. This problem was made even more serious by a lack of variance in the measures of combat effectiveness.
- The experienced officers utilized were predominantly Vietnam veterans. Hence, the unique nature of that combat environment may have an impact on the findings.

Having noted these problems, there are two further points to be made. The findings make excellent empirical and theoretical sense. Nevertheless, readers and potential users should be aware of these caveats and limitations. Second, based on the success of the methodology, a second research effort that will directly resolve many of these problems is planned. The next phase will include

- Analyses of unit performance from the 1973 war, where the "emerging threat" is better represented.
- Analyses of cases in which U.S. Marine Corps battalions encountered shock effects and/or surprise from enemy force levels, positions, weapons, or tactics. This should
 - Provide more cases of imperfect performance, thus increasing the variance in the dependent variable.
 - Allow projection of the attributes of units that are prepared to withstand shock and surprise, a key element in the early days of conflicts.

- Analyses of units over time as well as cross sectionally.
- Enlargement of the data set and collection of variables that are focused to resolve ambiguities and uncertainties resulting from the first research effort.

CONCLUSIONS BASED ON CRITICAL FACTORS DATA

The findings based on these analyses can be stated at two different levels. At the highest levels of abstraction, they suggest that "move, shoot, and communicate" is not a bad mandate for infantry units in the U.S. Marine Corps. Indeed, there would be grounds for real concern if, at these higher levels of abstraction, the research did not produce findings consistent with the previous experience of senior officers and the general theories of offensive action that have been developed in the past.

There are, however, some distinctive findings at even higher levels of abstraction:

- Supporting fires, when they are involved in an action, are likely to be extremely important, but they are associated strongly with only one element of the infantry battalion's own activities -- communications.
- Planning, command, and coordination are very tightly intertwined. The unit that cannot carry out these activities simultaneously will almost certainly fail.
- Planning and command during an engagement dominate the associations with combat effectiveness. Supporting fires and coordination are each perhaps one-quarter¹ as important as this set of functions.

¹ Based on the relative size of beta coefficients in the regression analyses carried out using marker variables from the three major factors.

- Coordination functions are an important element in determining combat effectiveness, but neither theoretically nor statistically do they become significant unless there is high-quality planning and command.

Dropping down one level of abstraction, it is also possible to draw conclusions at the level of 13 individual variables drawn from the critical factors data set.

- The single most important variable, "implementation of the principles of war," is a composite referring to actions that the unit executes on the battlefield after an engagement begins. Being prepared to execute and react is vital. Adaptive behavior -- the ability to recognize a situation and react -- appears to be central.
- The single most important function for unit success is maneuver during the action.
- Nonorganic supporting fires -- preparatory air, naval gunfire, and close air support -- are absolutely vital when they are involved in an action. Units must be trained to use them effectively if they are to achieve combat effectiveness.
- Communications are the second most important specific functions that an infantry battalion must perform well to operate effectively in combat. Units that communicate well also have a good record in use of supporting fires, although specific linkages to external units or commands do not show up as critical in themselves.
- Quality of planning and quality of information are important contributions to combat effectiveness. They are perhaps four times as important as awareness of enemy capabilities. This probably means (a) that there are not a large number of cases in the data set in which awareness of enemy capabilities was poor, and (b) that the information and planning functions depend on knowledge of the entire situation -- terrain, weather, enemy, disposition of own forces, and so forth -- rather than solely on knowledge of the enemy situation.

- Effective use of armor support is an important contributor in slightly over one-half of the cases analyzed. Emphasis on armor support in training would be an important element in preparing infantry battalions for combat.
- There is evidence that logistics support and artillery support have a positive impact on combat effectiveness, but there is little evidence that they have been frequent determinants of combat outcomes.

CONCLUSIONS BASED ON HISTORICAL DATA

The historical data viewed in isolation provide fewer insights than the critical factors data. There are, however, some interesting findings. It is important to note that these findings are based on a comparative standard of combat effectiveness, rather than the absolute standard used with the critical factors data. That is, the best cases of performance are being compared with the worst.

- Completion of a full cycle of unit training before commitment to a combat environment increases the probability of effective performance.
- Air support during an engagement increases the probability of effective combat performance of infantry offensive missions.
- Loss of internal contact among the components of an infantry battalion decreases the probability of satisfactory combat performance.
- U.S. Marine Corps infantry battalions have, in the cases studied here, performed less effectively when facing intense enemy artillery, intense enemy mortar fire, and enemy armor than when those factors were absent.
- Intense enemy infantry resistance has led to increased combat effectiveness by U.S. Marine Corps infantry battalions, perhaps by fixing the enemy in position.
- Marine Corps infantry battalions have performed more effectively against mixed and irregular enemy forces than against veterans and regulars.

- With the element of surprise on their side, U.S. Marine Corps battalions have had an increased probability of success, while they have generally been able to neutralize enemy tactical surprise situations.
- U.S. Marine Corps battalions composed of a mixture of regulars and veterans with replacements and reservists have performed as well as or better than regular and veteran units without reservists or replacements.
- Neither regimental-level training, division-level training, nor rehearsals for the specific engagements show a positive association with effective combat performance. The data suggest that they may detract from probability of satisfactory performance, perhaps by distracting the unit from more fundamental training.
- Prepared enemy positions have not caused lower probabilities of satisfactory performance. Like the intensity of infantry fighting, they may fix the enemy in a position where it can be destroyed by fire and maneuver.
- Artillery support during an engagement does not increase the probability of successful performance by a unit. Support is most intense during difficult combat. There appears to be room for improvement in doctrine and employment of artillery.
- Artillery preparations are negatively associated with effective performance. This may reflect the fact that difficult offensive missions are often preceded by heavy preparatory fires. However, these fires are not effective enough to bring up the probability of success to a level equal with other engagements.
- Moderate and light air preparations are likely to increase the probability of satisfactory effectiveness over that of engagements where no preparatory air is involved. However, heavy air preparations, associated by definition with difficult combat, do not in themselves increase the chances of successful combat.
- Ammunition expenditure, artillery ammunition availability, and mortar ammunition availability are not found to be either important aids or hindrances to effective combat performance, although consumption is higher during intense combat.

- Supply and delivery of supplies are not found to be either a major problem or a major determinant of combat effectiveness.

EXERCISE EVALUATION

The research team also related its findings to information systems such as the Marine Corps Tactical Warfare Simulation Evaluation and Analysis System (TWSEAS), the Marine Corps Combat Readiness Evaluation System (MCCRES), and exercise evaluation documents from a variety of Marine Corps commands at all levels. The research issue of interest was potential for innovation based on the combat effectiveness research effort.

There is an opportunity imbedded in the exercise system for developing a different way of evaluating units. The following discussion is predicated on a desire to use that opportunity. Basically, the argument is as follows:

- Exercises are opportunities for both learning and evaluating.
- The research reported in this volume indicates that the "adaptive behavior" of a U.S. Marine Corps infantry battalion is the most important component of combat effectiveness.
- Learning is a form of adaptive behavior.
- CACI researchers found that it is possible to project combat effectiveness based on a relatively small number of unit functions.
- Therefore, it is both fair and wise to collect data relevant to absolute levels of performance on those indicators and on the learning (adaptive) behavior of the unit over the course of the exercise.

In other words, it is possible to evaluate unit potential for effective combat performance both on the basis of absolute performance and on improvement rates observed over time. This approach would

- Force the use of more objective indicators, making identification of marginal areas of performance easier,
- Provide an opportunity to evaluate the unit for adaptability, a crucial area currently not examined, and
- Reduce the incentive for underreporting exercises both by creating more objective data and allowing demonstration of the learning curve for units during the exercise.

A visit by the principal investigator to the Marine Corps Air-Ground Combat Training Center (MCAGCTC) at Twentynine Palms, California, and observation of field exercises on that base suggested that a key element was being added to the exercise system in the Marine Corps -- the idea of comparability. A series of exercises involving live fire (and therefore no major live aggressor play) has been conducted at Twentynine Palms for battalions from both the East and West Coasts. All battalions have been given roughly the same mission, all faced the same terrain, and, with some variation, all have encountered the same scenario obstacles.

This element of comparability, particularly in light of the existence of TWSEAS technology, suggests that the Marine Corps is in a unique position to establish an evaluation system for projecting combat effectiveness from exercise data in two phases:

- An early phase to produce a baseline data set, validate the concept, and gain experience in its implementation, a phase in which a single, replicable exercise is evaluated, according to experimental design and quasi-experimental design principles, and
- A later phase in which the assumptions of the design are relaxed and data from different exercises, missions, terrain, and other key features are collected and compared with the baseline system.

Any data from any source can be utilized. Scores from the MCCRES system would make an excellent starting point since MCCRES is both comprehensive and standardized throughout the Marine Corps. There is also a great deal of highly structured information currently passing through the hands of umpires and the Troop Exercise Control Center (TECC) that could be extremely valuable. For example, interviews at Twentynine Palms indicate that umpires are currently recording, for each target attacked,

- The type and time of intelligence information received, which indicates the presence of a target,
- The time at which the target is acquired by the unit,
- The time at which fire is brought on the target (direct or indirect), and
- The time at which the target is declared neutralized, that is, hit by firepower sufficient to destroy it.

Figure 1 shows the type of data that might be generated from this information. The horizontal axis reflects hours into the exercise. The vertical axis is the time from the identification of a target by the unit (target acquisition) until the target is declared destroyed by the TECC. Note that these data reflect two things:

- The relative skill level of the unit at the time the exercise began (needing 8-10 minutes to destroy a target), and
- The learning or adaptive behavior of the unit.

Given the importance of factors like maneuver during action, implementation of the principles of war, use of supporting fires, and so forth, in the research reported earlier, learning behavior such as that illustrated in Phase I is an outstanding indicator of the quality of unit adaptability and combat readiness.

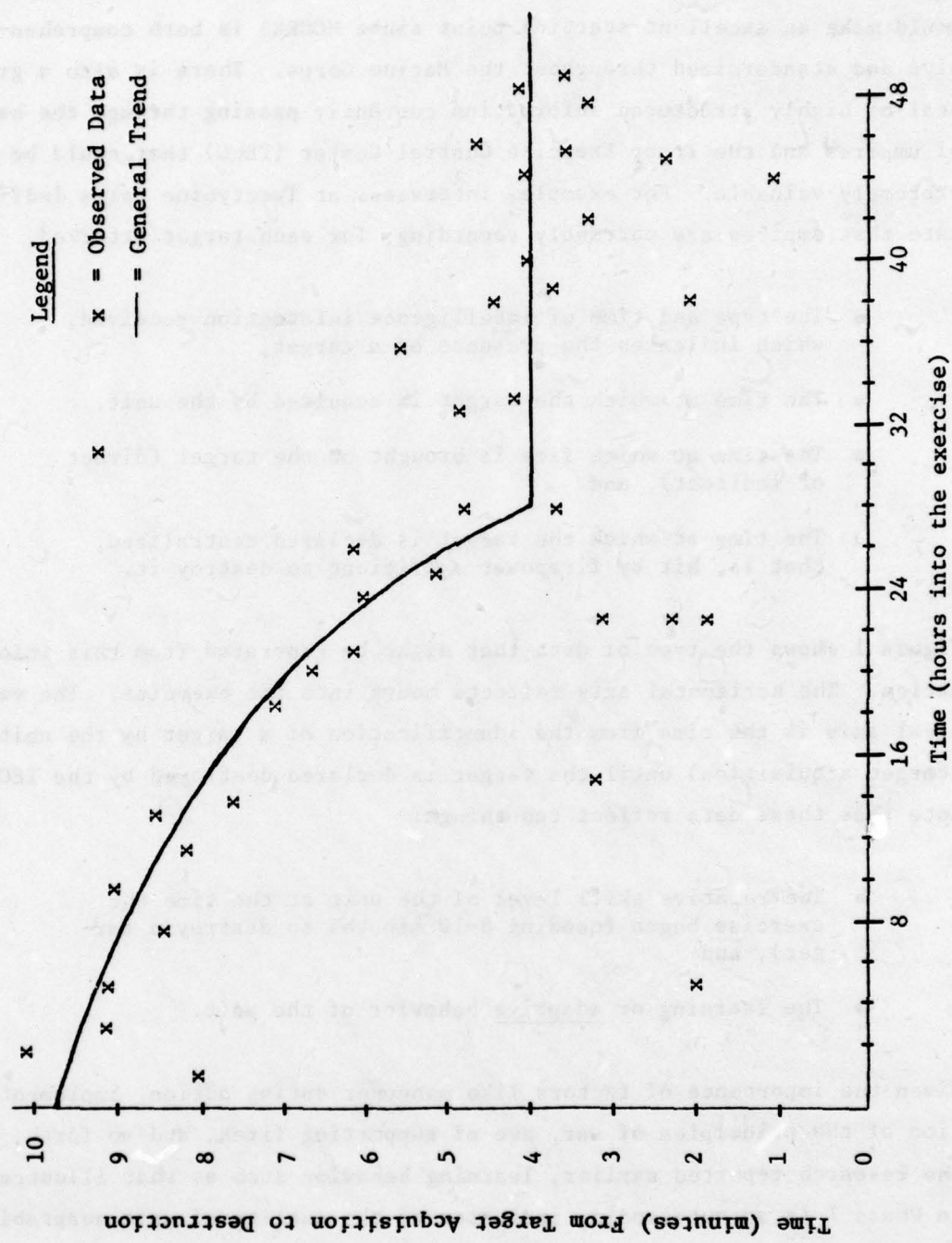


Figure 1. Adaptive Learning Behavior -- Engagement of Targets

It is not the purpose here to design a full evaluation system. However, a brief list of the types of key indicators that are directly available from exercise evaluation would include

- Speed of mission completion (where missions are comparable),
- Speed of response to enemy air threat,
- Variety of weapons utilized,
- Reaction (percentage success and speed) to electronic warfare,
- Speed of destruction of enemy armor, and
- Percentage of time out of communication with supporting arms.

Two key types of related analyses would also become possible. First, weighted performance scores could be produced. Second, and perhaps more important, research into the linkages between exercise performance measures and other variables would be practical. For example,

- The finding that completion of full unit training cycles is a predictor of combat performance could be examined for exercise situations;
- Unit maintenance ratings could be compared with exercise performance measures;
- Personnel turbulence variables could be used to estimate the impact of rotational policies on performance levels; and
- Number of weather-related injuries might be correlated with unit performance to establish overall levels of preparedness.

These analyses necessarily depend on the gradual development of a large enough data base to perform meaningful statistical analyses. Once sufficient information is present for these baseline data, comparisons with

other types of exercises, perhaps already collected through TWSEAS or another system, could be used to produce evaluations. This approach is, then, a collection of techniques and approaches already in existence but structured for effective analyses and weighted on the basis of research into effective combat performance.

STRUCTURE OF THE REPORT

This Executive Summary is bound separately to facilitate dissemination of information about the project. It is drawn from key paragraphs and segments of the Technical Report and reproduced as Chapter 1 of that volume. The full set of research procedures, statistical analyses, and findings is discussed in later sections of the Technical Report volume. There is also a set of separately bound Technical Appendices containing the 22 narrative descriptions and the coding forms utilized by the research team.