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Research Report 1447

AD-A186 998

**An Overview of ARI's Research
Program on the National Training Center:
Symposium Proceedings**

**James H. Banks and Patrick J. Whitmarsh
Editors**

**Presidio of Monterey Field Unit
Training Research Laboratory**



U. S. Army

Research Institute for the Behavioral and Social Sciences

August 1987



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A 186 998

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Report 1447	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AN OVERVIEW OF ARI'S RESEARCH PROGRAM ON THE NATIONAL TRAINING CENTER: SYMPOSIUM PROCEEDINGS		5. TYPE OF REPORT & PERIOD COVERED Final Report 1982-1985
7. AUTHOR(s) James H. Banks and Patrick J. Whitmarsh (Editors)		6. PERFORMING ORG. REPORT NUMBER --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute Field Unit P.O. Box 5787 Presidio of Monterey, CA 93944-5011		8. CONTRACT OR GRANT NUMBER(s) MDA 903-85-C-0472
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A794 511
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) --		12. REPORT DATE August 1987
		13. NUMBER OF PAGES 34
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) --		
18. SUPPLEMENTARY NOTES The contractual research related to this project was conducted under the technical monitorship of Dr. James H. Banks, ARI Presidio of Monterey Field Unit (Contract MDA903-85-C-0472).		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Research Data Base (RDB) Integrated Relational Data Base System (INGRES) National Training Center (NTC) NTC Instrumentation System (NTC-IS) Battalion Task Force (TF) Unit Performance System		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This set of papers presents an overview of the Army Research Institute's National Training Center (NTC) Research and Development Program. The papers were developed for a symposium conducted during the meeting of the Military Testing Association in October 1985. They examine the nature of measurement and interpretation of unit performance, leadership measurement and development, types and quality of NTC information currently available for research, and analyses of battalion live- (continued)		

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ARI Research Report 1447

20. Abstract (continued)

fire and force-on-force performance. Standardized procedures in support of NTC operations are recommended to improve both training and the NTC Lessons Learned program.

Keywords: INGRES (Integrated Relational Data Base System); Battalion Task Force

Accession For

NTIS GRA&I ☒DTIC TAB ☐Unannounced ☐

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Special*A-1*

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**An Overview of ARI's Research
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**James H. Banks and Patrick J. Whitmarsh
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**Presidio of Monterey Field Unit
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**Office, Deputy Chief of Staff for Personnel
Department of the Army**

August 1987

**Army Project Number
2Q263743A794**

Education and Training

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FOREWORD

The Army Research Institute (ARI) has a major research program in support of the National Training Center (NTC). The purpose of this program is to support improved training at the NTC and develop Lessons Learned methodologies for training, doctrine, organization, personnel, and equipment.

This set of papers was developed for a symposium conducted at the meeting of the Military Testing Association in October 1985. The purpose of the symposium was to present an overview of current program research to members of the research community who might not be aware of the NTC, its characteristics, or the research program.

The effort described in this report was conducted by (a) ARI's Field Unit at the Presidio of Monterey, California; and (b) the Leadership and Management Technical Area (LMTA) at ARI Headquarters in Alexandria, Virginia. The mission of the Presidio of Monterey Field Unit is to increase combat performance capabilities of Army units by improving unit performance measurement and evaluation methods, unit training programs and management tools, and the NTC and home station data base. LMTA's task was to assess existing leadership training and data collection processes at NTC and to determine the potential for enhancing the quantity and quality of leadership data collected at NTC, as well as the means for improving the development of leaders participating in exercises at NTC.

The research tasks that support these missions are entitled (a) Field Feedback from National Training Center to Improve Collective and Individual Training, organized under the "Maintain Force Readiness" program area; and (b) Methods for Measuring Leader Performance, organized under the "Develop Units" program area.

This research effort was sponsored by the Combined Arms Training Activity (CATA) under the Letter of Agreement entitled "National Training Center (NTC) and Unit Home-Station Training and Feedback System," dated 16 September 1985. The CATA Lessons Learned Division was briefed on the information in this document and indicated its intention to use the results.



EDGAR M. JOHNSON
Technical Director

AN OVERVIEW OF ARI'S RESEARCH PROGRAM ON THE NATIONAL TRAINING CENTER:
SYMPOSIUM PROCEEDINGS

EXECUTIVE SUMMARY

Requirement:

To support improved training at the National Training Center (NTC) and development of Lessons Learned methodologies for training, doctrine, organization, personnel, and equipment.

Background:

The National Training Center (NTC) was established at Fort Irwin, California, to train battalion task forces under highly realistic and intense conditions not available at home station. However, combined arms training exercises of the scale, complexity, and realism of those at the NTC have never before been conducted, nor has such detailed information on unit performance been available for analysis and interpretation. Extensive research and development are required to obtain maximum, Army-wide benefits from the NTC.

Findings:

The papers in this report describe models of battalion task force performance, leadership measurement, types and quality of NTC data, and preliminary results of analyses of unit performance. The papers were prepared for and presented during a symposium conducted at the annual meeting of the Military Testing Association, San Diego, California, 21-25 October 1985.

Utilization of Findings:

The research described in this report is being used to support the design and utilization of the NTC Training and Research Data Base (RDB) at ARI Presidio of Monterey, California. A fully supported permanent NTC RDB is the key to obtaining maximum benefits from the NTC, beyond those provided by the training itself. In addition, the information in this report will help to inform the research community of the present and future capabilities of the NTC for meeting Army-wide research and development needs.

AN OVERVIEW OF ARI'S RESEARCH PROGRAM ON THE NATIONAL TRAINING CENTER:
SYMPOSIUM PROCEEDINGS

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AN OVERVIEW OF ARI'S RESEARCH PROGRAM ON THE NATIONAL TRAINING CENTER

James H. Banks
U.S. Army Research Institute Field Unit
Presidio of Monterey, California

The National Training Center (NTC) was established at Fort Irwin, California, to train battalion task forces under highly realistic and intense conditions that are not obtainable at home station. A second purpose was to provide information to help the Army evaluate its training, doctrine, organization, equipment, and readiness. Thus, the NTC provides capstone training and potentially permits measurement of the output of the Army unit training system. However, combined arms training exercises of the scale, complexity, and realism of those at the NTC have never before been conducted, nor has unit performance information of this richness been available for analysis and interpretation. ARI's NTC-based research program was established to help get the maximum benefits from the NTC and to increase the effectiveness of ARI's overall research and development (R&D) program. I am going to provide an overview of the program, outline a few of the problems in measurement and interpretation of unit performance, and in diagnosing and correcting problems when they are detected, and generally describe what we hope to do. Other speakers will describe the NTC, the types of data available and potentially available, and some early analyses.

MEASUREMENT AND INTERPRETATION OF TASK FORCE PERFORMANCE

The NTC provides an unparalleled opportunity to objectively measure and analyze unit performance to detect strengths and weaknesses, typical performance, performance ceilings, and trends. Measurement and interpretation must take into account both the nature of the Task Force and the combat environment in which it must function.

The Battalion Task Force is a complex system containing maneuver, intelligence, fire support, air defense, mobility/countermobility, and combat service support elements or subsystems, all bound together by a command and control subsystem, as shown in Figure 1.

The combat environment for the Task Force--or the NTC as a high-quality simulation--is complex, rapidly changing, and uncertain. "Correct performance" always involves trade-offs of capabilities, opportunities, and risks, and always in the context of the commander's orders and intent for a mission. Moreover, friendly actions are opposed and countered by an intelligent adversary. Thus the problems faced in combat, by the leader and by the soldier, are typically "fuzzy"--not clearly stated, where the needed information is not all available, where no set procedure can be used to reliably produce an answer, and where there may be no single answer that is demonstrably correct.

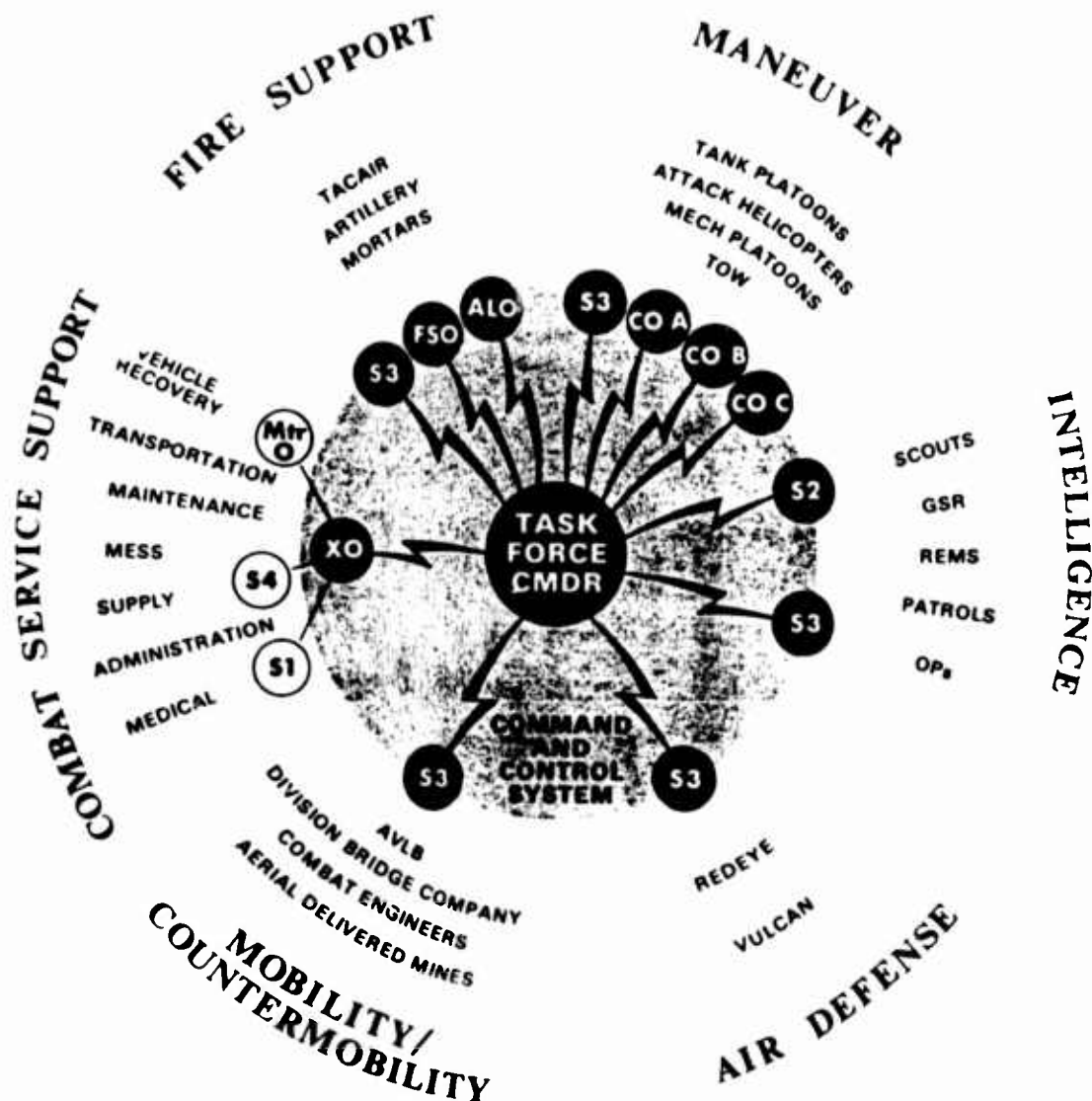


Figure 1. One model of the Battalion Task Force as a system.

Given the complex nature of the Task Force and the combat environment and requirements, the problems in measuring and interpreting unit performance at the NTC are twofold. First, facts do not "speak for themselves": rather, they are meaningful only in relation to other facts and expectations. These relationships can be informal (e.g., "common sense") or quite elaborate, formal, and explicit, as in scientific theories. For the major relevant problem areas--how to fight, how to evaluate collective training and performance, how humans learn, how to instruct teams--the theories are not well developed or integrated. We, therefore, need descriptive models of the Task Force system and subsystems to guide observation and interpretation. Initially these can be derived from doctrine but they need expansion, synthesis, and empirical validation. Second, enormous practical problems exist in operationally defining concepts in terms of procedures and data elements, from the NTC or elsewhere, and actually conducting the desired analyses. While "quality control" of NTC data can certainly be improved, it will never be perfect because it is collected during real training exercises. In addition, many aspects of performance that might be desirable to observe are not readily collectable by

automated methods, and capabilities for nonautomated collection are limited and hard to reliably and validly implement. Under these conditions, analyses must be highly robust, i.e., permit interpretation despite data gaps and complex interactions. Traditional data analysis methods are not well suited for such applications. However, human beings do, routinely, process and use information of this type. Therefore, we will be interested in developing "expert" approaches and models to supplement conventional methods.

THE NTC AS PART OF THE UNIT PERFORMANCE SYSTEM

The NTC is not a stand-alone activity but, rather, is part of the Army training system. Interpretation and correction of performance observed at the NTC require not only measurement of performance but also understanding of the effects and interactions of inputs to unit performance. The model in Figure 2 views the unit as an open system composed of subsystems--missions and values, technology and training, personnel, structure, and leadership. Thus, factors internal to the unit--training validity, timing, completeness, and mastery level; leadership priorities; individual and organizational values; morale; cohesiveness; etc.--are all in active and continual interaction with each other and with the environment in which the unit operates. Inputs include those found in Table 1.

To obtain maximum benefits from the NTC, it must be treated as a part of the unit performance system. Therefore, interpretation and improvement of performance must consider both home station factors and outside inputs to the unit. ARI's R&D concept, shown in Figure 3, takes this into account. In this concept, research on NTC training and performance, on home station factors, and on the various inputs to units will be conducted because of their importance in their own right to Army sponsors and clients of the ARI program. In addition, ARI has established the Unit Performance R&D Center at its Presidio of Monterey Field Unit, with scientific and Army training expertise and computer analytic and data base capabilities for handling data from NTC and other sources. As the data base is established over time, it will permit development of a scientific and practical approach to the measurement and interpretation of unit performance and, for the first time, effective research on the relationships and interactions of factors in the unit performance system.

The primary sponsor for the NTC-based program is the Combined Arms Training Activity that is the Army executive agent for use of NTC information for assessment and improvement of Army training, training support, doctrine, organization, and materiel. It is expected that research at the Center will also potentiate the effectiveness and value of other ARI research and development.

The remaining papers provide more detail on the present stage of the research and on requirements for improving the Army-wide benefits of the NTC. Mr. Whitmarsh describes the data presently available, as well as some requirements for integrating data from multiple NTC sources and for improving data quality. Dr. Pence describes requirements for improving measurement and feedback on leader behaviors at the NTC. Mr. Forsythe and Dr. Doherty present preliminary analyses of unit performance on the NTC live-fire range. Finally, Ms. Nichols presents an analysis of unit performance in force-on-force

INPUTS

- 0 HIGHER HEADQUARTERS POLICIES/PROCEDURES
- 0 RESOURCES
- 0 TASKINGS
- 0 TRAINING SUPPORT
- 0 DOCTRINE
- 0 PERSONNEL
- 0
- 0
- 0
- 0

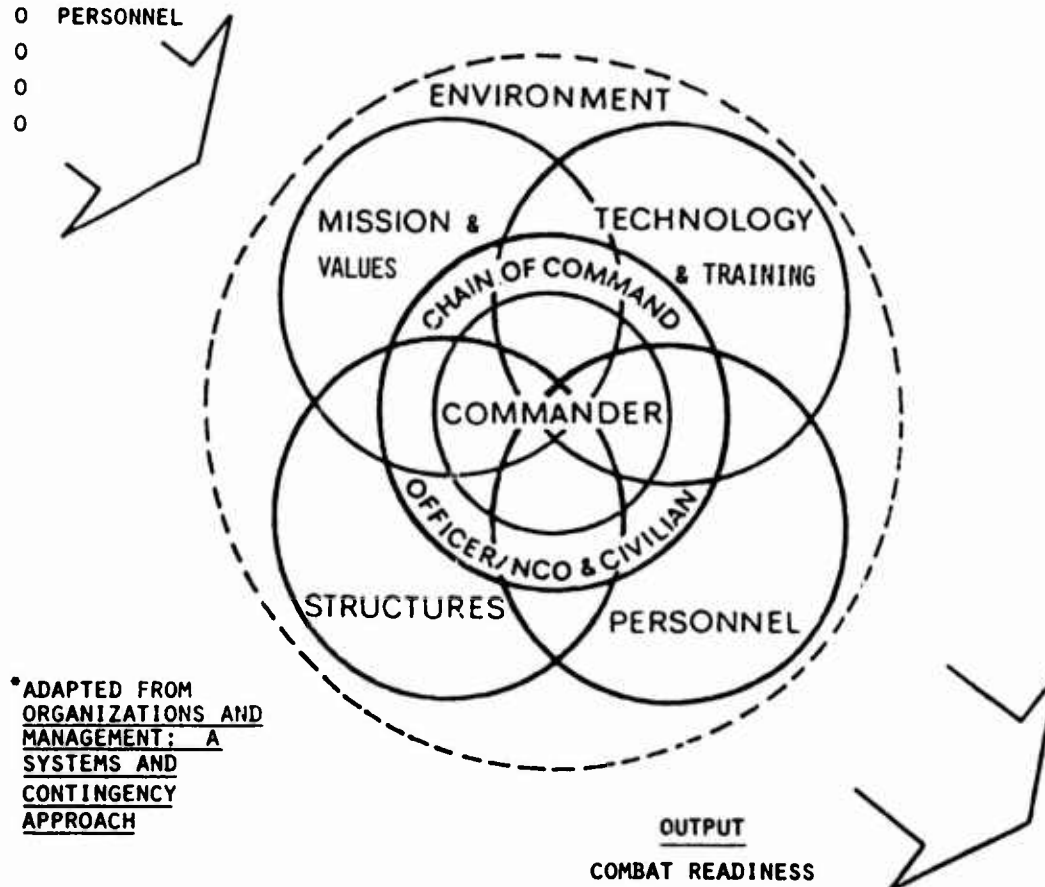


Figure 2. A model of unit performance.

Table 1

Inputs to Units

Doctrine	Threat analysis, strategy, missions, tactics, T0&E.
Institutional Training	Validity, timing, completeness, mastery level, training evaluation, performance accountability, values, quality of exported training support products.
Unit Training	Training resources, training evaluation, performance accountability, quality of aids and literature, fill level/job assignments/MOS mismatch, force modernization/transition, housing and post services, management skill, values, leadership.
Personnel	Recruiting, selection, classification, job design, aptitude measurement, school assignment, unit assignment, promotion, retention, elimination, retirement, pay and benefits.
Equipment	Operability, maintainability, durability/reliability, trainability, performance capability, cost.
Logistics	Speed and range, quantity/lift, survivability, economy/consumption, cost.
Societal Values	Attitudes toward the military, national goals, pride, etc.

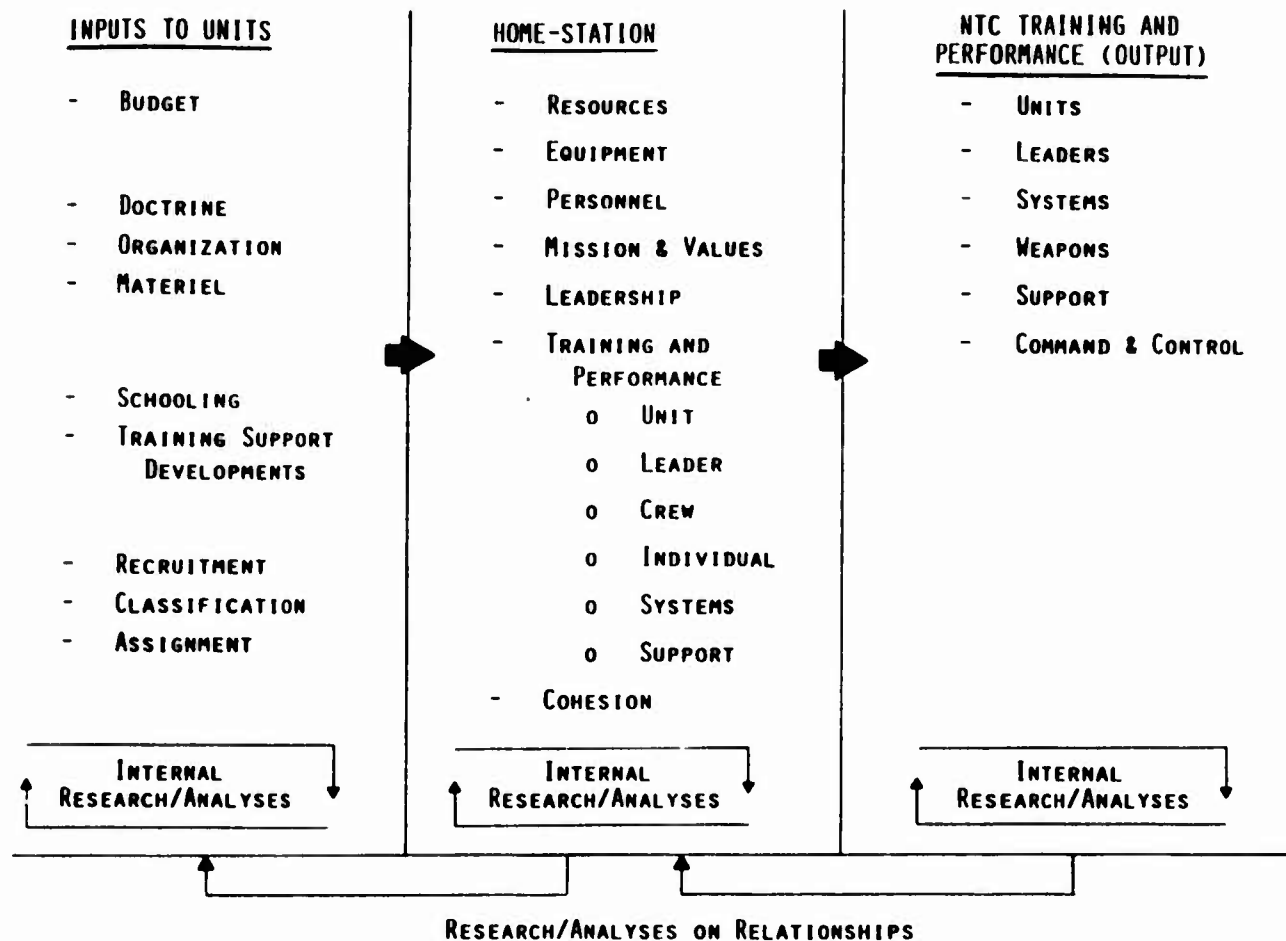


Figure 3. Research and development concept for unit performance system.

exercises. Together, these papers will help to introduce the research community to the present and future capabilities of the NTC.

TYPES AND QUALITY OF NATIONAL TRAINING CENTER DATA

Patrick J. Whitmarsh
U.S. Army Research Institute Field Unit
Presidio of Monterey, California

The National Training Center (NTC) at Fort Irwin, California, provides U.S. Army heavy battalion task forces (TFs), controlling brigade headquarters, and supporting units training with Multiple Integrated Laser Engagement System (MILES) and Live Fire under realistic combat conditions not found at home station. The NTC is in a position to provide Army decision makers information on battalion task force training, doctrine, and readiness in the context of the Army Training and Evaluation Program (ARTEP). One objective of the Army Research Institute Presidio of Monterey Field Unit (ARI-POM) NTC Training Research Program is to establish an operational, computer-supported NTC Data Management and Analysis System to support research on these complex issues.

The purpose of this paper is to present the types of NTC information currently available, research problems with respect to collecting and merging information, data quality issues, and a discussion of standardized procedures.

TYPES OF INFORMATION AVAILABLE

Operations Plan. The Operations Plan is a planning document provided by the NTC to the TF controlling brigade to be executed by the battalion TFs at the NTC. Information typical of the Operations Plan include the MISSIONS that will be executed, and the general Astronomical data across the time period included; a SCENARIO PLAN; a TIME/EVENT SCHEDULE for Mechanized and Armor TFs, and Opposition Force (OPFOR); a GENERAL SITUATION narrative describing a hostile international condition with potential for war between the two superpowers; OPFOR and TF with GENERAL SITUATION UPDATE(S); an ANALYSIS OF AREA OPERATIONS narrative describing a General Description of The Area, Military Aspects of The Area, and Effects of Characteristics of The Area; a DEFENSE INTELLIGENCE REPORT on the Handbook Krasnovian Army (OPFOR); and a series of OPERATION ORDERS (OPORD), WARNING ORDERS, and accompanying overlay maps.

Take-Home Package (THP). The THP is prepared for each TF Commander by the NTC Training Analysis and Feedback (TAF) Division. The document contains narrative and numerical descriptions of unit performance at the NTC and recommends additional training for home station training. THP information includes: a general overview of the purpose, scope, and organization of the THP; a summary description of the 14-day training including missions conducted, equipment losses of both sides by mission, live-fire performance measures, and performance trends; the After Action Reviews (AARs) for each mission including narrative description, critical events for each Operating System, and statistical data on equipment losses and radio transmissions; and a list of videotapes included in the THP.

Company/Team Take-Home Package. The Company/Team Take-Home Package is prepared by the TAF Division for each TF company/team. The document describes

critical events in the Plan, Prepare, and Execute phases for each NTC mission for each Company/Team.

Video Tape After Action Review. The video tape After Action Review (AAR) is prepared by the TAF Division on each TF mission. It is intended to supplement the THP in establishing future home station training. The AAR, considered the key to training effectiveness, is a tactical discussion among all soldiers conducted by the senior trainer immediately following each mission training exercise.

Unit After Action Report. The Unit After Action Report is a detailed narrative and numerical description provided by the brigade commander to the division commander on the NTC training period. The Unit After Action Report narrative includes: a Narrative Overview; each TF Commander's Comments; Task Organization; specific comments and recommendations on Command and Control, Maneuver, Fire Support, Intelligence, Air Defense, Mobility and Counter-mobility, Combat Service Support, and Survivability; and recommendations for improvement of the NTC experience. The numerical contents include maintenance, major assembly usage, vehicle requirements, and budget.

National Training Center Instrumentation System (NTC-IS) Data Tape. The NTC-IS is divided into the Range Data Measurement Subsystem (RDMS), Range Monitoring and Control Subsystem (RMCS), and Core Instrumentation Subsystem (CIS). The RDMS provides real-time position/location and engagement event data on all players equipped with telemetry instrumentation during the training with the Multiple Integrated Laser Engagement System (MILES) weapon simulation. The RMCS monitors and controls all activities on the engagement simulation and live-fire ranges. The CIS provides all real-time data processing and interactive play capabilities needed to monitor, command, and control all engagement simulations. The NTC-IS Data Tape contains information replay of the battle for display on "NTC workstation" graphics terminals and also for input into the ARI-POM NTC Research and Training Data Base. The tape data are formatted for the INGRES relational data base management system (RDBMS) on the DEC-VAX 11/780 computer system. INGRES was selected based on the research data base (RDB) criteria: to maximize data element correlations; to be user friendly, retrieval efficient, and modularly expandable; to allow researchers reliably supported continuing study; and meet computer system specifications. INGRES facilitates research by manipulating the existing 61 data tables. Continuing research anticipates restructuring, adding, and deleting variables with INGRES.

RESEARCH PROBLEMS

Collection. Data collected from the battlefield must be interpreted from a given context. To get a complete picture for off-line analysis, we need plans, scenarios, orders, communications, accurate position location, and firing data, as well as data on transient events such as smoke and on factors that are basically not instrumentable (e.g., what did the commander know?). This ideal is not readily obtainable. ARI is working with NTC personnel to obtain all available data and to improve future data collection.

Merging. Certainly one major issue is integration of information from multiple sources to permit more complete and effective analysis and inter-

pretation. The ARI-POM NTC Research and Training Data Base is designed to accommodate text as well as numerical data thereby providing an efficient RDB.

Figure 1 indicates the concept for integrating Operations Plan, THP, Company/Team Take Home Package, Video Tape After Action Review (convert audio to text), and Unit After Action Report in the NTC Training and Research Data Base. The NTC-IS Data Tape is entered by tape drive through NTC Translator and Loader software and INGRES by a computer system operator. To simplify subsequent NTC-IS Data Tape operations, an NTC Data Tape "backup" is performed whereby a user can access the data tape through INGRES with "read only" privilege. The user has access to the tape drive, statistical packages and user file system, and the RDB through INGRES with "read only" privilege.

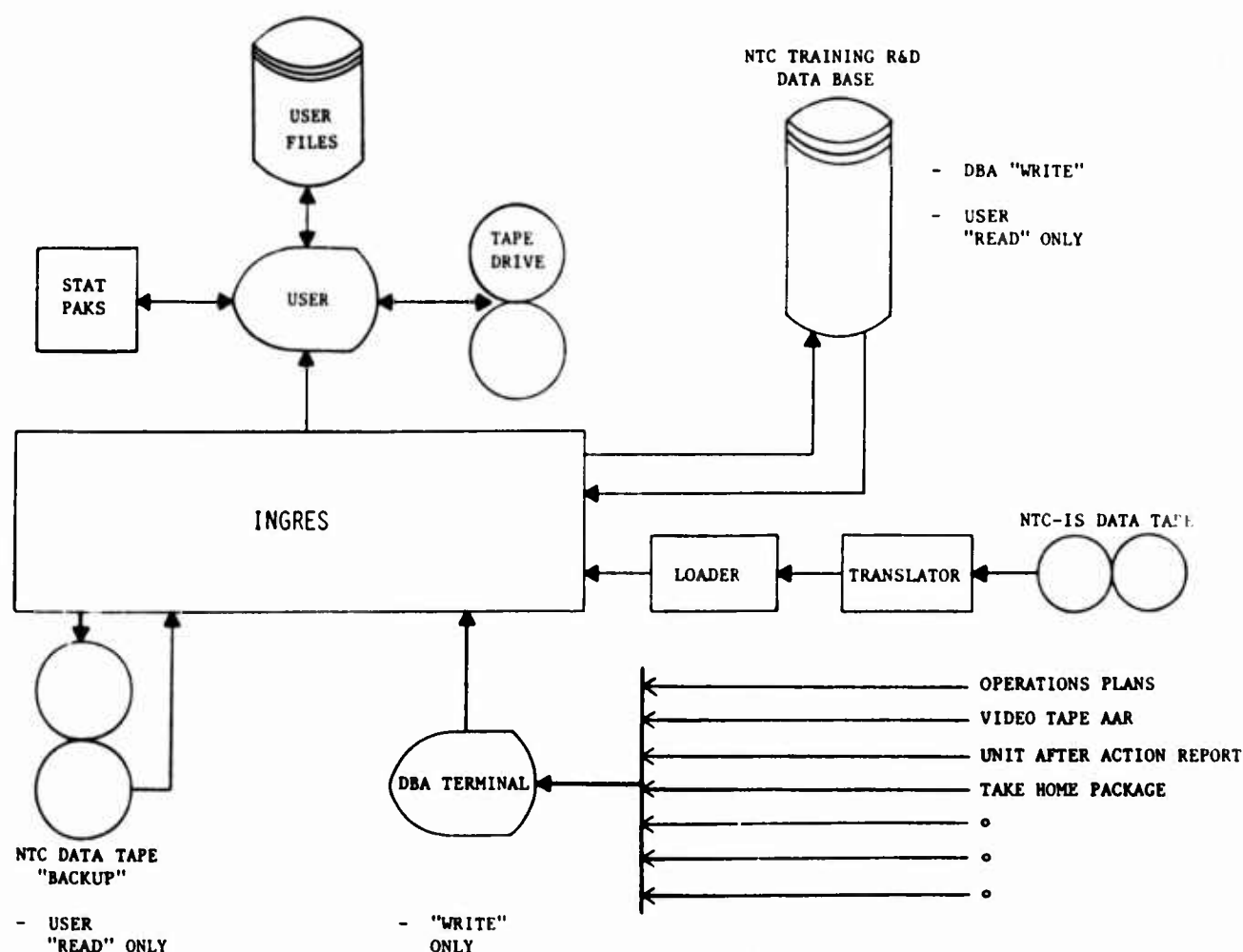


Figure 1. ARI-POM NTC Research and Training Data Base.

DATA QUALITY ISSUES

Accuracy. Previous investigations have attempted to utilize the NTC data sources without knowledge of the conditions under which the data were collected, the result of which has been to limit the research to one data source. With multiple sources and types of data and efficient merging, comparisons will be possible to identify data reliability. As a first step we investigated the accuracy of data entry on vehicle loss and radio communication variables across THP, INGRES RDB, Graphics Displays, and Summary Statistics derived from the NTC-IS Data Tape for seven selected TF missions. The results indicated perfect agreement, in all cases, between the Summary Statistics and the INGRES RDB only. Some of the problems are attributed to missing data entries by operator personnel and possible software errors.

STANDARDIZED PROCEDURES

Operational Control Units. Data quality can be improved by use of standardized procedures, at the same time recognizing data quality can never be perfect because some data are collected during real time. However, procedures can be designed to support both training at NTC and improve data utility collected for off-line analysis. We, at this time, are preparing a procedural document to assist the NTC CIS Operations.

CONCLUSION

The NTC represents a complex environment providing the Army, for the first time, an opportunity to evaluate training readiness of TF units under simulated combat conditions. This paper examined types of information currently available, identified some research problems, discussed data quality issues and standardized procedures for the purpose of supporting the NTC RDB. A fully supported NTC RDB is the key toward effectively analyzing unit performance, thereby providing for an efficient and effective fighting force.

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LEADER PERFORMANCE CRITERIA AT THE NATIONAL TRAINING CENTER (NTC)

Earl C. Pence
U.S. Army Research Institute

INTRODUCTION

The presentations you have heard thus far have described the operation of the NTC and the types of data currently generated during the training exercises. For the most part, the data describe what happened during the preparation and execution of a mission and performance at the unit level (battalion, company, or platoon). The focus of the current presentation is on the development of a new data collection system that will provide information to aid in understanding why certain events or outcomes occur at the NTC. The new data collection system is being developed to aid the NTC Observer/Controllers (OCs) in observing and recording performance indicators of leaders at the battalion, company, and platoon levels. (OCs accompany the units to enforce rules of engagement and collect information for training feedback to unit members.)

THE CURRENT SYSTEM

The OCs at NTC have, of course, been observing the actions of leaders at NTC since the time the training center first opened. In fact, the After Action Review (AAR) process used to provide feedback after the end of missions at NTC is a leader-oriented process in that the information at the battalion and company levels is provided to the key leaders in the battalion. The information itself, however, is focused on unit performance with little emphasis on leader performance except to probing questions as to why leaders made certain decisions or took particular actions that the OCs judged as critical to the outcome of the mission.

In August 1984, the Leadership and Management Technical Area of ARI, in conjunction with the Center for Army Leadership (CAL) at Ft. Leavenworth, began work on a leadership research effort at the NTC. The initial task was to assess existing leadership training and data collection processes at NTC and to determine the potential for enhancing the quantity and quality of leadership data collected at NTC as well as the means for improving the development of leaders participating in exercises at NTC. During the fall of 1984 a research team composed of a researcher from ARI and a Major in the research branch of CAL spent a 2-week rotation in the field at NTC. The team traveled with the OCs and focused their observations on the manner in which the OCs gathered information, recorded observations, and provided feedback to leaders training at NTC. The research team also recorded the conditions under which the OCs worked.

The views expressed in this paper are those of the author and do not necessarily reflect the view of the U.S. Army Research Institute or the Department of the Army.

INITIAL RESEARCH FINDINGS

The key findings from the research team's initial visit to the NTC are listed on the first slide.

SLIDE 1

INITIAL RESEARCH FINDINGS

The observer/controllers receive little or no training.

Considerable variation between OCs on decision rules guiding observations and feedback.

OCs made notes of their observations in a variety of means:

- * 3 x 5 note cards
- * Small memo pads
- * In grease pencil on map cover on hood of jeep
- * In grease pencil on top of ammo can

Notes used primarily for AARs and relatively little of the information was captured permanently.

A second round of observations in the field at NTC by the same research team in June 1985, followed by interviews with approximately 30 past and current NTC OCs, confirmed all of the findings noted above. The only major new finding from the second data collection effort was that the company OCs were now required to produce a company-level Take-Home Package that made it even more critical for them to record their observations during or immediately after each mission.

The observations in the field and the interviews with the OCs indicated the need and opportunity for enhancing both leader performance data collection and leader development at NTC. The primary means for accomplishing both goals will be to develop a system that encourages more systematic, consistent, and accurate observation and recording of leader performance followed by feedback in the AAR on key leader events impacting on unit performance. The system must meet the criteria contained on the next slide to be acceptable to the OCs who would use it.

THE DESIGN OF THE SYSTEM

There are actually two distinct challenges to be met in designing the data collection system for leader performance criteria at NTC. The first would be to develop the appropriate content for the data collection system (i.e., identify performance dimensions and operational measures of the performance dimensions). The second challenge will be to design the format or technology that provides a data collection process acceptable and useful to the NTC OCs.

SLIDE 2

CRITERIA FOR SYSTEM ACCEPTABILITY

1. The system must not increase OC work load.
 2. The system must be convenient to use under extremely harsh environmental conditions.
 3. The system must provide information that can be used almost immediately for preparing and delivering AARs.
-

CONTENT

Development of the actual performance dimensions will be accomplished using a modified BARS (Behaviorally Anchored Rating Scale) development procedure. The key steps in this process are listed in the next slide.

SLIDE 3

STEPS IN DEVELOPMENT OF CONTENT FOR LEADER PERFORMANCE MEASURES

1. Conduct OC interviews to identify potential performance dimensions and examples of effective and ineffective leader performance.
 2. Develop performance dimensions with definitions.
 3. Work with OCs to develop behavioral anchors, performance indicators, and decision rules.
 4. Evaluate anchors and performance indicators.
 5. Develop OC training program.
 6. Validate the leader performance measures using unit performance measures as criteria.
-

The performance indicators and decision rules referred to in steps 3 and 4 will be guidelines to be used by the OCs in determining the appropriate rating to be given on any particular performance dimensions. For example, on a performance dimension related to communication by the leader, the performance indicators and decision rules would probably include a series of questions that the OC could ask subordinate leaders and soldiers to determine the extent to which mission-related information has been communicated. The leader's rating on the communication dimensions would depend, in part, on the answers the OCs received when they asked the questions. The use of such performance indicators and decision rules combined with guidelines on recording specific leader behaviors would be part of the OC training program.

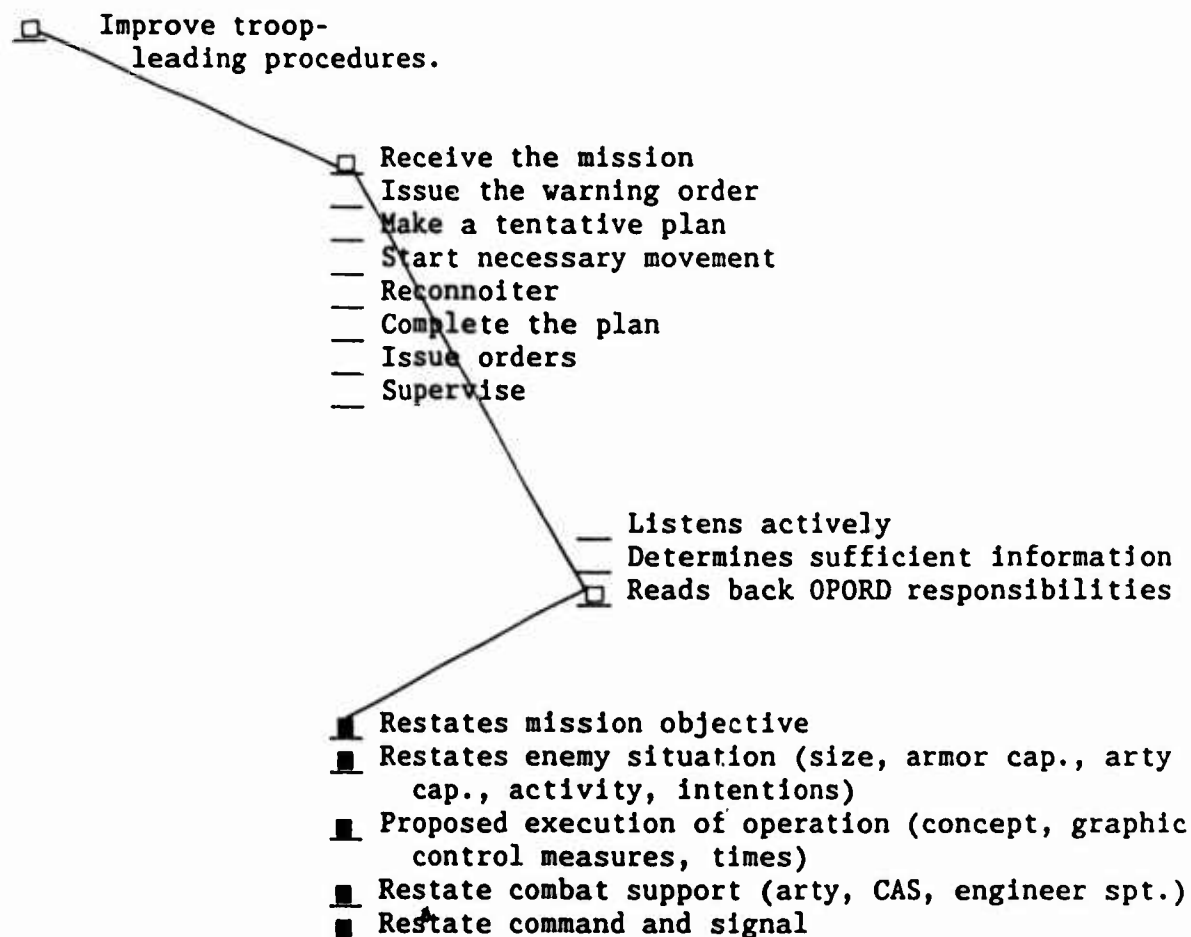
FORMAT OR TECHNOLOGY

The most difficult challenge for the data collection system is to package the system using a format or technology that meets the criteria regarding no increase in OC work load, convenience of use, and immediate information availability. The most promising concept for meeting these needs involves using an electronic clipboard under development by ARI's Training Research Laboratory. The clipboard is a small, hand-carried device that makes use of a touch sensitive screen for recording data. The format of the screen is programmable and seems ideal for a menu-driven data recording system. The menus operating on the screen could provide branching that would enable fairly detailed recording of observations or ratings with only two to four touches to the screen. The system would require no key punching and would be considerably more efficient and convenient to use than traditional check lists. Slide 4 illustrates how such a menu-driven data collection system might work.

SLIDE 4

MENU-DRIVEN DATA RECORDING SYSTEM

Menu Picks:



The output of data or information from the clipboard could take any of a number of formats. The data could be presented on the clipboard screen, it could be printed, or it could be transferred directly to a computer. This variety of options would meet the need for immediate feedback of information in the field as well as eliminating the need for handling paper documents in the transfer of data for research purposes. Specific observations recorded on pre-printed, color-coded 3x5 cards could be used to supplement the data collected on the automated system for illustrative purposes to explain ratings and provide feedback during the AAR.

PROGRESS ON SYSTEM DEVELOPMENT

Content

Interviews with the NTC OCs were conducted in June 1985 and the initial content analysis of the interview transcripts has been completed. Examples of the types of leader performance information obtained in the interviews are illustrated on Slide 5.

This information will be combined with previous research findings to develop an initial set of approximately 12 leader performance dimensions that will be taken to NTC for modification and operationalization by the OCs.

Format

The initial development of the electronic clipboard is nearing completion and a number of the devices will be available for pilot-testing by ARI during the current fiscal year. The initial pilot testing of the clipboards will occur at a site other than NTC. Preliminary work on a format that may serve as the basis for designing the menu-driven system to be programmed into the clipboard is currently underway.

SLIDE 5

CHARACTERISTICS OF EFFECTIVE LEADERS AT NTC

PLANNING AND UTILIZATION OF TIME

Prepares detailed plans and gives specific guidance on what he wants to happen. (Communicates plans well, gives complete and clear operations orders.)

Conducts planning such that his subordinates have time to prepare for the next mission (manages time well).

Uses time effectively and sets work priorities.

COMMUNICATION OF INTENT

Communicates his intent as a commander clearly.

Disseminates information to the lowest level possible and keeps people informed.

Understands his commander's intent.

SUPERVISION AND STANDARDS

Knows what he wants to see on the ground (knows the standard).

Communicates what he wants with authority (communicates standards).

Enforces standards and holds individuals accountable for doing their jobs (makes rapid corrections).

Supervises tasks after giving order (i.e., checks progress, walks the line, inspects positions, or ensures this is done).

BATTALION PERFORMANCE ON THE LIVE-FIRE RANGE AT THE NATIONAL TRAINING CENTER (NTC)

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INTRODUCTION

The training benefits derived by units training at the National Training Center (NTC) have been of considerable interest to the U.S. Army. The Army Research Institute (ARI) has developed and initiated a programmatic research effort to assess these benefits. As a preliminary step in this effort, an exploratory data analysis of the performances of battalion task forces on the live-fire range at the NTC was conducted. As stated by Tukey (1977) the purpose of exploratory data analysis is to be detective in nature, not confirmatory. Thus, the investigation reflects incursions into the data designed to explicate the structure of the data rather than to confirm a particular model of the data. Using the data provided in 54 Take-Home Packages for the period of early 1982 to late 1984, it was possible to examine battalion performance for three live-fire scenarios: Defend from a Battle Position (Day), Defend from a Battle Position (Night), and Movement to Contact (Day). The presentation of these data was organized around three primary issues:

1. Has battalion performance changed over time at the NTC?
2. How do the performances of the Armor and Mechanized Infantry Task Forces differ?
3. What factors seem to be related to performance at the NTC?

DATA SOURCE

The live-fire data were extracted from 54 Take-Home Packages (THP). These data represented the live-fire performances of 96% of the battalion task forces that trained at the NTC from early 1982 to late 1984. Data from the remaining 4% (two battalions) of the task forces were either not available, or erroneous due to target equipment malfunctions on the live-fire range. It was felt that exclusion of this small amount of data from the investigation would not adversely affect its generalizability or statistical power.

The live-fire results reported in the THP generally included the following data:

- o Number of Targets
- o Percentage of Enemy Targets Killed
- o Tank Rounds Fired
- o Tank Round Hits and Kills
- o Tow/Dragon/Viper Laser Firings
- o Tow/Dragon/Viper Laser Hits and Kills
- o Number of Each Friendly Weapon System

These data presented ample opportunities for conducting preliminary research on battalion task force performances at the NTC. The performance data were first extracted from the Take-Home Packages and a computer data base was established to assist in sorting and analyzing the data. In all cases, unit designations were omitted to preserve unit anonymity.

DATA ANALYSIS

As indicated earlier, an exploratory data analysis (Tukey, 1977) approach was employed in this study. This resulted in a series of analyses being conducted and all aimed at understanding the structure of the data from the live-fire range at the NTC. Specifically, analyses were aimed at satisfying the first two objectives of the exploratory data analysis approach (Hartwig & Dearing, 1979):

1. Understand each variable as a separate entity.
2. Understand pairs of variables as relationships.

A number of data analytic techniques were applied to the live-fire data base. The initial efforts used univariate descriptive statistical techniques. The results of these were used to generate a picture of performance at the NTC. Generally, the results were transferred into graphic display. Somewhat more sophisticated techniques, including T-tests and regression, were used to examine bivariate relationships between different factors and performance at the NTC.

An important decision influencing the results contained in this report was the selection of a primary variable as the measure of task force performance. Of the available variables, the one that seemed to most directly reflect unit performance was the Percentage of Enemy Targets Killed.

It was also decided that because this report was designed to provide some early insights into unit performance changes at the NTC, only individual battalion performances would be considered and analyzed. That is, their performances would not be aggregated and analyzed at the brigade and division levels. However, an analysis of that order would be a logical follow-on to this analysis once a better understanding of the performance data at the battalion level is developed. For the same reason, only the effects of the tank ballistics are considered in this study although the performance of the Tow/Dragon/Viper laser firings on the live-fire range might also be investigated for a subsequent study. (It must be noted, however, that the Tow/Dragon/Viper performance analysis would not be as meaningful as the tank performance analysis due to the narrow range in values for the laser firings as compared to the tank ballistics data.)

RESULTS

Using the Percentage of Enemy Target Kills data as an indicator of meaningful unit performance on the live-fire range at the NTC and comparing the battalion performances in the first 18 months with those of the next 12 months of a 2-1/2-year period (early 1982 to late 1984), this study found that:

1. The percent of targets killed by the tanks of the Armor and Mechanized Infantry Task Forces increased between the first and second periods of this study.
2. The increase in percent of targets killed between the first and second periods was attributable to both one-time visitors to the NTC and to repeat visitors to the NTC. Therefore, the differences in performance were a function of some phenomena associated with time and not just some advantage factor acquired through repeat visits to the NTC as might be expected.
3. The change in performance on the live-fire ranges was probably not a function of the activities involved in the operation of the live-fire range by NTC cadre; i.e., the live-fire exercises were conducted in a uniformly consistent manner throughout the 2-1/2-year period of this study.
4. The change in percent of targets killed over time was not related to gunnery accuracy as this did not change over time. However, a significant increase in the volume of tank rounds fired by both the Armor and Mechanized Infantry Task Forces in the second period was likely related to the observed increase in target kills.
5. The increase in rounds fired was related to an increase in number of tanks assigned to the task forces (particularly to the mechanized units) in the second period and to an increase in the number of rounds fired per tank.
6. A positive and statistically significant relationship was found between the number of rounds fired per tank and the percent of enemy targets killed. This relationship was strongest for the day attack and day defend missions.

REFERENCES

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- Tukey, J. (1977). Exploratory Data Analysis. Reading, MA: Addison-Wesley, Inc.

ANALYSIS OF NTC FORCE-ON-FORCE PERFORMANCE

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INTRODUCTION

U.S. Army battalions have been training at the National Training Center (NTC) at Ft. Irwin, California, since 1981. The objective of NTC training is to provide a facility where units can undergo essential combined arms training that cannot be accomplished at home stations due to physical limitations and the prohibitive cost of providing a realistic training environment. A secondary objective of NTC training is to gather information that can be used to contribute to the improvement of doctrine, tactics, training systems, equipment, and procedures in the U.S. Army.

In support of the NTC information-gathering objective, the Army Research Institute (ARI) has developed a research program that includes as a technical objective the collection, organization, and analysis of NTC data in order to assess those training benefits that may be accrued by the units training at the NTC. This report is an investigation of the force-on-force data that are contained in the Take-Home Packages (THPs) that are compiled and issued to the training units at the end of each NTC rotation. The focus of this study was the relationship between task force performance on the NTC battlefield and the force modernization (i.e., the changeover from H- to J-MTOE Series organization) that took place during the period under study.

BACKGROUND

The NTC concept is geared to the training of the battalion task force (TF). Each battalion task force participates in approximately six force-on-force exercises during a 2-week rotation period at the NTC. These exercises usually are more or less evenly divided between offensive and defensive operations using laser-based engagement simulation instrumentation to provide real-time casualty assessment. The simulator, the Multiple Integrated Laser Engagement System (MILES), is used on all principal weapons, and casualties are assessed when a weapon fires and the MILES laser hits a target. In addition to force-on-force training, units also perform three missions on the live-fire range during their rotation. The results of the investigation of live-fire performance are presented in a separate paper for this symposium.

The scenario dictates the force ratios of the combatants. While terrain and scenario options are limited, no two scenarios are exactly the same. When the TF conducts defensive missions they are always attacked by an opposing force (OPFOR) that replicates a Motorized Rifle Regiment. When task forces conducted offensive operations, they originally encountered a defending Motorized Rifle Company. However, in the summer 1984, the force ratio was changed to deploy a defending Motorized Rifle Battalion (-). Analysis of the effect of this change resulted in no significant differences, so the data were pooled across time periods.

SCOPE

Sample

The 64 battalions that underwent training at the NTC during the period February 1982 through January 1985 are represented in this analysis. The 64 battalions represent the rotations from six divisions and two separate brigades located in the Continental United States (CONUS). The 64 battalions included 32 armor and 32 mechanized infantry units that were cross reinforced to form 64 combined arms task forces (i.e., 32 armor heavy and 32 mech heavy TFs). Two rotations by the opposing force--i.e., two MTOE battalions permanently stationed at Ft. Irvin--were also included in the sample. The OPFOR battalions did not undergo the standard rotation series of exercises but rather performed a mini-ARTEP. However, the data extracted for the two missions performed by the OPFOR battalions (i.e., movement to contact and defend in sector) were not substantially different from the data in the rest of the sample and so were included in the analysis.

Data Sources

As previously mentioned, Take-Home Packages (THPs) are prepared and issued to the training units at the termination of each NTC rotation. Separate packages are prepared for the respective armor and mechanized infantry task forces. The THP is an overall description of unit performance during the rotation and includes statements of performance trends during the 14-day rotation period. The THP is the final compilation of all after action review scripts and encompasses an assessment of all seven operating systems, live-fire gunnery data, and TF and opposing force aggregate losses.

The force-on-force results are reported in the THPs in several formats and include the following data:

- o TF and OPFOR vehicle loss summaries for Offensive Engagement Simulation (OES) operations.
- o TF and OPFOR vehicle loss summaries for Defensive Engagement Simulation (DES) operations.
- o Numbers of TF vehicles started and killed for each mission.
- o Numbers of OPFOR vehicles killed for each mission.

Offensive and defensive operations summary data were extracted from the 64 THPs. Mission-specific data for the six most commonly performed missions (i.e., movement to contact/meeting engagement, deliberate day attack, deliberate night attack, defend in sector, delay in sector, and defend from a battle position) were also extracted from the THPs and combined with the summary data to construct the data base for this analysis. Each individual task force was coded to preserve anonymity and the data were then subjected to a number of statistical operations.

Data Analysis

The task force was designated as the unit of measurement and the data were divided into two groups in order to identify differences in task force performance at the NTC during the period that force modernization was taking place. The first group included all H-MTOE Series rotations occurring between February 1982 and January 1985 and the second group included all J-MTOE Series rotations occurring during the same time period. The two groups were further refined to identify differences between mechanized infantry and armor TFs within the H- and J-Series categories.

The limited scope of force-on-force data available in the THPs severely constrained the analysis in several areas. For example, information on the numbers of OPFOR tanks and APCs starting each mission was not available in the THP thus prohibiting the derivation of percent of enemy vehicles killed during an exercise. Although the force strengths for Motorized Rifle Regiment and Motorized Rifle Company are available in FM 72-1, The Tank and Mechanized Infantry Battalion Task Force, Appendix H, this does not allow for instances of vehicle breakdown in the field, numbers of vehicles actually available to the OPFOR during specific individual missions, and so forth. For the purposes of this report, it was decided that the assumption of consistent standards for OPFOR strengths would not be made.

Two measures of battalion task force performance were selected for study. The first, "%Lost," represents the percentage of TF vehicles lost on the NTC battlefield--i.e., numbers of TF vehicles killed at each mission/numbers of TF vehicles started at each mission. This measure was available for each TF vehicle type killed (i.e., APCs to include TOWs and tanks) as well as an aggregate value ("Total Vehicles Lost") that combined all vehicle types. Results of preliminary analyses revealed that TOW losses were not obviously different from APC losses and so TOW data were incorporated into the APC data to produce an APC/TOW category.

The second dependent measure, "Casualty Exchange Ratio," consists of the ratio of vehicle casualties for the two forces--i.e., numbers of TF vehicles killed/number of OPFOR vehicles killed--and was calculated for both specific vehicle types (i.e., APC/TOW and tanks) and across vehicle types.

RESULTS

Analysis of the percentage of task force lost indicated little difference between H-Series and J-Series. The only statistically significant difference occurred for the percentage of APC/TOWs lost on the offensive missions. The direction of this difference indicated that J-Series task forces lost a lower percentage of APC/TOWs on the average than did H-Series task forces (13% fewer APC/TOWs were lost by J-Series task forces--significant at the $p < .01$ level). The difference was found for both Armor and Mechanized Infantry task forces, though the size of the difference was greater for the Mechanized Infantry (18% fewer APC/TOWs lost by J-Series Mechanized Infantry task forces compared to 14% fewer APC/TOWs lost by J-Series Armor task forces significant at the $p < .01$ level). No statistically significant differences occurred in the contrasts between H-Series and J-Series on the defensive mission summaries.

The lack of a clear trend in performance differences between H- and J-Series units precludes any inferences being drawn concerning the force-multiplier effects of reorganization under the J-Series MTOE.

Analysis of the casualty exchange ratios again produced significant differences only for the offensive missions. The contrast between H-Series and J-Series showed no statistically significant differences for either Armor or Mechanized Infantry task forces. This was true regardless of mission type. However, there was a statistically significant difference between the two types of task forces in the exchange ratio for APC/TOWs on offensive missions. The mechanized infantry task forces under H-Series had consistently greater casualty exchange ratios than the Armor task forces (H-Series mechanized infantry task forces averaged two more combat vehicle losses per kill in offensive operations than did H-Series armor units--significant at $p < .05$). Analysis of the casualty exchange ratios also showed considerable variability in performance across the six mission types examined in the study, with the greatest fluctuations found in the Movement to Contact mission.

Based on the casualty exchange ratios, the OPFOR outperforms the battalion task forces by achieving a much higher kill ratio of tanks and APC/TOWs when on both the offense and defense as compared to the TFs when they are on the offense or defense.

DISCUSSION

The results of the analyses indicate that the determinants of force-on-force performance are more complex than the current information from Take-Home Packages allow. Considerable variation in battalion task force performance was found in the results reported above. Yet, only a small portion of that variation seemed to be related to differences in the organization of task forces (H-Series vs. J-Series) or to the type of task force (Armor vs. Mechanized Infantry). Further, the differences in performance along these dimensions were not consistent either in terms of type of mission (offensive or defensive) or type of performance measure (percentage lost or casualty exchange ratio). This lack of systematic results and the relatively small size of the relationships provide considerable evidence that force-on-force performance can only be understood in the full context in which that performance took place. To accomplish that end, it will be necessary to employ the full range of NTC digital data and possibly supporting data such as the commo tapes.

Despite the limitations of the results, several findings are of note. There was considerable variation in performance of the task forces measured either in terms of percentage of vehicles lost or by the casualty exchange ratio. Variation in performance was greater for offensive missions than for defensive missions. This suggests that either the causal mechanisms for offensive performance are more complex than for their defensive counterparts or that training in the elements of defense are more universally applied and incorporated.

Another finding of note is that performance variation was least visible in the loss of tanks. Differences between type of task force and task force organization, when tested on the percentage of tanks lost or the casualty

exchange ratio for tanks, failed to produce any significant differences. As tanks constitute the primary weapon system on the NTC battlefield, performance characteristics in this area are particularly important. The high level of loss in this area and the lack of relationship to the analysis variables studied here indicate a more generic cause for the troubled performance. The nature of this cause needs to be studied.

The last significant finding from these results concerns the performance of the reorganized task forces (J-Series). Since performance for these task forces was not found to be consistently better than their earlier counterpart (H-Series), it is important to determine why this should be the case. One possibility is that the addition of new assets independent of sufficient training in the deployment of those assets may result in inefficient and ineffective use. That is, the new assets may in fact be consumed at a higher rate than the previous assets (under the prior organization) because the task force commander is unable to incorporate them into the scheme of the maneuver. Whether this hypothesis is true or whether some other causes are at work can only be determined by the more comprehensive analyses to be performed in the future.

As indicated in the Data Analysis Section, the analysis of force-on-force performance data was necessarily limited by the type and level of information available for analysis. While recognizing those limitations, it was felt that there was much to be gained by exploring performance variations to determine the extent of their existence and whether they were related to the macro-level variables available in the Take-Home Packages. The results of this analysis have accomplished that objective. They have demonstrated that variation does exist and that the macro-level variables while related do not account for all of the observed differences in performance. Further, the analyses have pointed to several areas to be pursued in the more comprehensive analyses to be conducted with the NTC digital data. Thus, the results reported here represent the jumping off point for this new research effort.