Research Report 1435

A Research Concept for Developing and Applying Methods for Measurement and Interpretation of Unit Performance at the National Training Center

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U. S. Army
Research Institute for the Behavioral and Social Sciences

January 1987

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: ARI Research Report 1435	2. GOVT ACCESSION NO.: AD-A181073
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): A RESEARCH CONCEPT FOR DEVELOPING AND APPLYING METHODS FOR MEASUREMENT AND INTERPRETATION OF UNIT PERFORMANCE AT THE NATIONAL TRAINING CENTER	5. TYPE OF REPORT & PERIOD COVERED: Final Report January 1985-December 1986
	6. PERFORMING ORG. REPORT NUMBER: --
7. AUTHOR(s): Thomas K. Forsythe	8. CONTRACT OR GRANT NUMBER(s): MDA903-85-C-0471 MDA903-85-C-0472
9. PERFORMING ORGANIZATION NAME AND ADDRESS: The BDM Corporation 2600 Garden Road, North Building Monterey, CA 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q263743A794 511
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600	12. REPORT DATE: January 1987
	13. NUMBER OF PAGES: 42
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): --	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)

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18. SUPPLEMENTARY NOTES

This research plan was technically monitored by James H. Banks, Contracting Officer's Representative.

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

National Training Center (NTC)
NTC mission effectiveness criteria
NTC mission critical tasks
Unit performance measurement at NTC
Training implications of unit performance at NTC
Systems theory
Observer guides
Army Training Evaluation Program (ARTEP)

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

This report describes a research concept for accomplishing the task of developing and applying methods for measuring and interpreting unit performance at the National Training Center (NTC). The plan presents the background, methods, procedures, resource requirements, and resulting research products of this research effort.

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Office, Deputy Chief of Staff for Personnel
Department of the Army

January 1987

Army Project Number
2Q263743A794

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FOREWORD

The Presidio of Monterey (POM) Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) Training Laboratory performs research and development in the areas of collective training and unit performance measurement. Of special interest to the POM unit is research in the area of combat performance measurement and the translation of those measurement results into training and doctrine implications for the Army.

The National Training Center (NTC) at Fort Irwin, California, presents an excellent opportunity to provide this performance data on Army battalion task forces because of the high-quality combat simulation and extensive database available for analysis. The research concept presented in this document provides the framework for the development and application of an analytical model, or structure, which directs the research effort toward the mission critical events to be observed at the NTC, the development of their standards of performance, measures of performance, and measures of effectiveness.

The operationalization of this research concept is designed to provide a study of the relationship between the performance of certain critical mission tasks and the mission outcomes. Products emerging from this research effort will be in the form of NTC-specific Army Training and Evaluation Programs (ARTEPs) and observer guides which direct performance evaluators to the critical events which directly impact upon the mission outcomes. Further, development of the concepts and methodologies which are operationalized through this research effort holds great promise for the evolutionary development of standardized Army-wide performance measurement systems. The Army's capability for determining unit readiness could thereby be improved through the measurement of high-payoff training events.

This research effort described in this report was monitored by the POM Field Unit. The research task which supports this mission is entitled Field Feedback from National Training Center to Improve Collective and Individual Training and is organized under the "Maintain Force Readiness" 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 their intention to make use of the results.

EDGAR M. JOHNSON
Technical Director

A RESEARCH CONCEPT FOR DEVELOPING AND APPLYING METHODS FOR MEASUREMENT AND INTERPRETATION OF UNIT PERFORMANCE AT THE NATIONAL TRAINING CENTER

EXECUTIVE SUMMARY

Requirement:

The purpose of this report is to present a research concept for developing and applying methods for measuring and interpreting unit performance at the National Training Center (NTC). The valid measurement of unit combat effectiveness during peacetime has been a long-term Army goal. The NTC provides an excellent opportunity to provide this performance data on Army battalion task forces because of the high-quality combat simulation and extensive database available for analysis.

Procedure:

A conceptual systems model for viewing task force performance was developed. In order to operationalize this model, two measurement systems are to be simultaneously developed. One system will be the measurement of mission results and the development of mission effectiveness criterion variables. The second measurement system will be the measurement of the performance of critical mission tasks and the effectiveness of that performance.

Findings:

The approach, methodology, and procedures for developing a unit performance measurement system are detailed. The milestones and personnel requirements and expected research products are also presented. The system which is presented takes a systemic approach to task force performance measurement and provides the basis for data-gathering activities at the NTC to support both training and off-line analyses of "Lessons Learned."

Utilization of Findings:

The measurement systems described in this research concept are now being developed. The strawman measurement systems will be tested at the NTC, evaluated, and refined for operational use. The concepts and methodology have implications for use by the Combined Arms Center and schools in development of Army Training and Evaluation Programs (ARTEPs) and other training support materials.

A RESEARCH CONCEPT FOR DEVELOPING AND APPLYING METHODS FOR MEASUREMENT AND INTERPRETATION OF UNIT PERFORMANCE AT THE NATIONAL TRAINING CENTER

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OVERVIEW

Purpose

The primary purpose of this report is to present a research concept for developing and applying methods for measuring and interpreting unit performance at the National Training Center (NTC). It discusses the background, methods, procedures, milestones, and resource requirements for accomplishing the task.

Introduction

The valid measurement of unit combat effectiveness during peacetime has been a long-term Army goal. Of particular interest is the translation of unit performance results into training and doctrine implications for the Army (although such performance results may also provide feedback on the equipment, manning and organizational structure(s) of the type of units being studied). The NTC presents an excellent opportunity to provide this performance data on Army battalion task forces because of the high-quality combat simulation and extensive database available for analysis. The use of this database, however, requires an analytic framework, or model, which directs the research effort toward the mission-critical events to be observed, how they are to be recorded and analyzed, and their standards of performance, measures of performance, and measures of effectiveness.

Research Requirements

With the above understanding and appreciation for performance analyses at the NTC, the Army Research Institute (ARI) is conducting research, sponsored by the Combined Arms Training Activity (CATA), on the development and application of concepts and methods for measurement and interpretation of unit performance at the NTC. This effort addresses two primary requirements. One is to develop a system for assessing and explaining the effectiveness of unit performance at the NTC. Such a system, when operationalized, would permit determination of training and doctrine strengths and weaknesses. It also would allow for expanded research on predictor-criterion studies regarding unit performance. The second requirement involves the development of two by-products of this measurement system. These products are: (1) an ARTEP-like document for the NTC which presents the Tasks, Conditions, and Standards in clear, unambiguous, and descriptive terms such that performance of the units can be uniformly measured using the performance data generated at the NTC; and (2) observer guides on selected issues which would assist in operationalizing the ARTEP as a training assessment tool. These two requirements,

then, provide the focus for the technical approach - one that is punctuated with requirements for military expert input, non-armchair field visits, and extensive doctrinal research in order to provide realistic and meaningful measures of performance.

METHODS AND PROCEDURES

General Concept

The key conceptual requirements in this research effort are in the terms measurement and interpretation of unit performance at the NTC. The ultimate purpose for this understanding of unit performance under combat-like conditions during peacetime is to determine its training, doctrine, equipment, and organizational implications thereby allowing the Army to better prepare itself for combat. Our technical approach, therefore, is to use the explanatory paradigm which is concerned with explaining performance results. Thus, explanatory variables must be identified as to their role in relation to the phenomenon of study and hence require some theoretical or conceptual underpinnings. Because this research effort concerns performances of organizations, i.e. battalion task forces, we turned to organizational theory to provide us with a focus for shaping a conceptual model. Within the last decade there seems to have been a shift in emphasis away from management and structures of organizations towards an investigation of the "systems" of organizations -- the study of inputs, processes, outputs, feedback, the environment -- and how they relate to each other. This conceptual view of organizations - a relationship of subsystems - seemed most appropriate for this explanatory research effort and, therefore, was selected as the conceptual framework for this study. A general systems model is shown at Figure 1.

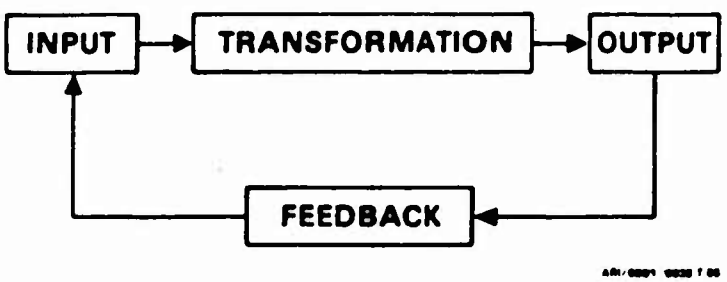


Figure 1. General systems model.

In relating the research task at hand - i.e. measuring unit performance at the NTC - to the systems model, we are able to transform the systems components into NTC and NTC-related subsystems as shown in Figure 2, next page.

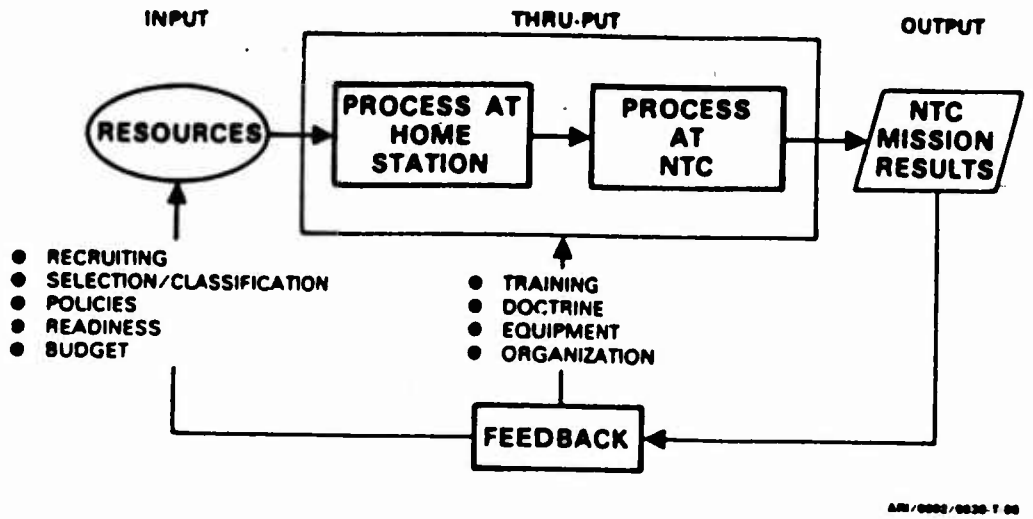


Figure 2. Systems model for viewing task force performance.

With this conceptual model in hand, we address its operationalization in response to the research requirements.

Operationalizing the Concept

Our general approach in operationalizing the concept will be to simultaneously develop two measurement systems under two separate tasks. One system will be the measurement of the mission results and the development of mission effectiveness criterion variables. The second measurement system will be the measurement of the performance of critical mission tasks and the effectiveness of that performance. Used together in a relational mode, these systems are intended to measure and explain unit performance effectiveness which is the first research requirement. The fulfillment of this first requirement will then allow for the development of the NTC-specific ARTEP and the observer guides which constitute the second research requirement. The methodology for accomplishing these requirements are discussed next.

Requirement 1: Development of a System for Measuring and Explaining Unit Performance Effectiveness at the NTC.

Task 1: Development of combat mission effectiveness criterion variables. This task addresses the "output" subsystem, or NTC Mission Results. The initial analysis effort, which will become the cornerstone for this study, will be directed at developing the effectiveness criteria for each mission conducted at the NTC. We believe that in order to provide any meaningful feedback in terms of training, doctrine, etc., as reflected by the performance results, the overall mission effectiveness must be established. This notion is depicted in Figure 3.

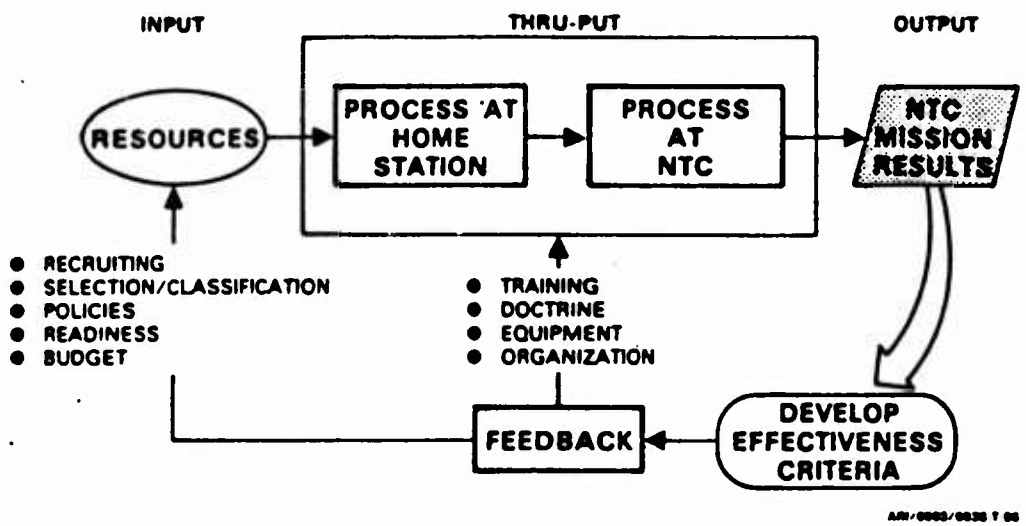


Figure 3. Developing feedback based on mission effectiveness criteria.

This approach is also consistent with the need to develop a complete model of performance within the explanatory framework, and with the prior literature such as Roberts (1980) who stresses that: "one cannot move very rapidly to the independent variable side of the unit performance problem until questions of effectiveness are better addressed." Finally, but no less important, is that this conceptualization recognizes the uniqueness of the individual missions in terms of their requirements, difficulty, and accomplishments. Thus, measures of mission effectiveness can be derived for each battalion task force on a mission-by-mission basis. After all, the accomplishment of the tactical mission is the

ultimate purpose of a combat unit. Therefore, the unit's effectiveness should be measured in terms of its mission results, a notion that has strong support by military scholars such as Sarkesian (1982) in his edited book on combat effectiveness.

The methodology for fulfilling this first task is through the undertaking of the following seven subtasks:

Subtask

1.1: Develop Measurement Model for Evaluating Mission Results at the NTC.

1.2: Establish Mission Performance Conditions.

1.3: Set Mission Performance Standards.

1.4: Determine Measurement Requirements which will Result in Measures of Mission Performance.

1.5: Design Mission Criterion Performance Effectiveness Indices.

1.6: Test Measurement System Feasibility.

1.7: Prepare Technical Report.

Implementation procedures for each subtask are discussed next.

Subtask 1.1: Develop measurement model for evaluating mission results at the NTC. The ultimate purpose for measuring unit effectiveness is to determine its "causal" antecedents in order to provide direction for training and doctrine formulation for the type of units being assessed. Implementation of this kind of an explanatory research requires the development of a model or conceptual framework which can be used to guide measurement development and statistical testing. In this particular subtask the requirement is to develop a model for measuring mission outcomes and assessing performance effectiveness, and will be a refinement of the model depicted in Figure 4, next page.

As can be seen in Figure 4, the structure for measuring mission effectiveness should consist essentially of four parts: **Conditions, Mission Standards, Performance Assessment,** and the resultant **Mission Effectiveness Criteria.** Each of these four parts is discussed in greater detail below.

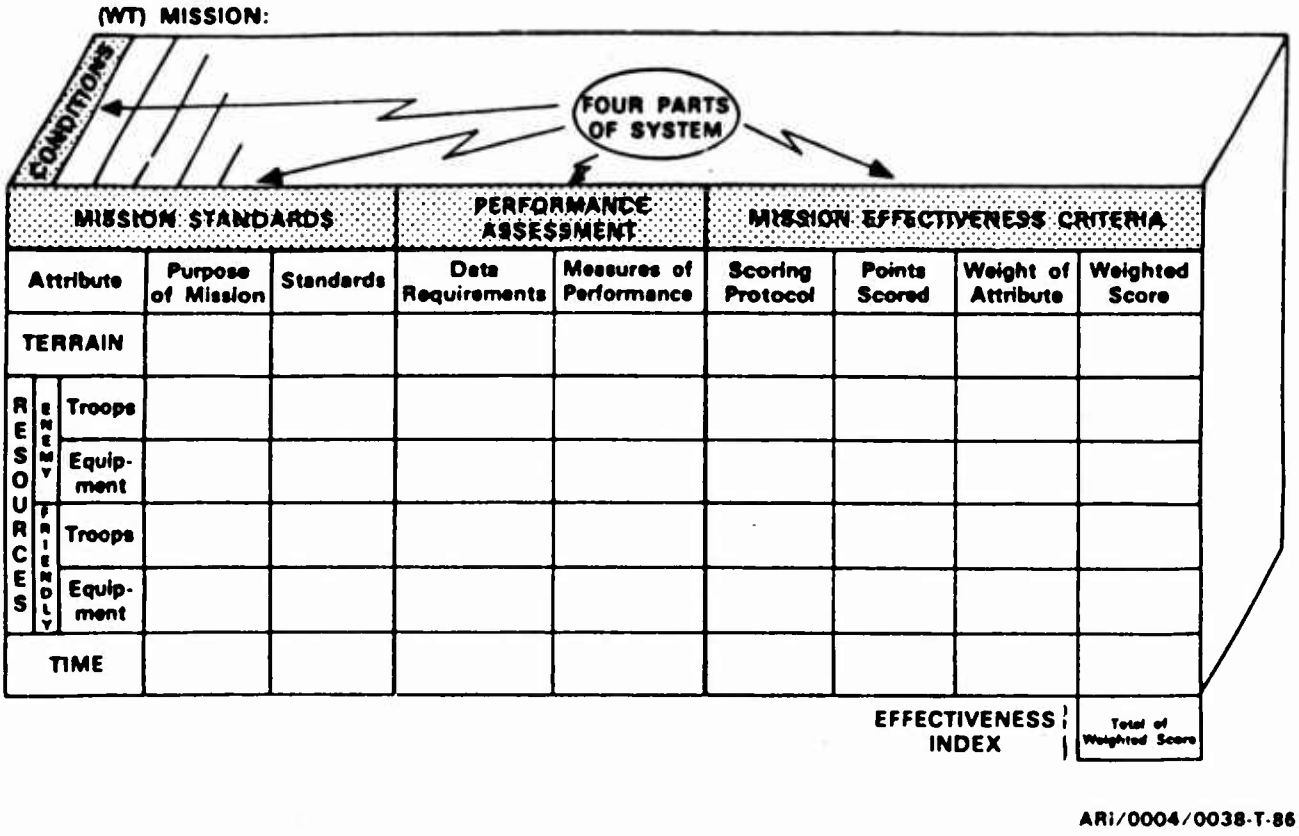


Figure 4. Mission effectiveness measurement system.

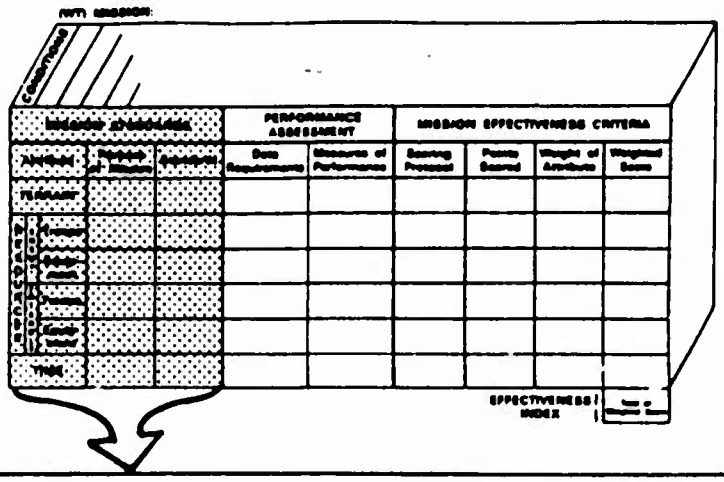
Subtask 1.2: Establish mission performance conditions. In order to establish performance standards, we must first establish the varying conditions under which the task forces perform their respective missions. To accomplish this subtask, the battle scenarios used for each of the NTC missions (and rules for preparing variations) will be collected, reviewed, and documented. Our experience tells us that no two scenarios are exactly alike as a new scenario is prepared for each battalion task force. Therefore, the review process will involve 60-90 scenarios. However, we anticipate that our investigation will reveal a central core of common conditions that would have such a significant impact upon expected performance results that they must be taken into consideration when establishing performance standards. We expect that these conditions will be expressed in METT-T (Mission, Enemy, Troops, Terrain and Weather, and Time) terms as they represent the major factors that are considered by the military in determining courses of action to achieve desired results. These critical conditions will be analyzed and specified. The Combined Arms Training Activity (CATA) will be asked to review the results of this subtask for suggestions and recommendations.

Subtask 1.3: Set mission performance standards. In order to determine the effectiveness of a unit, its performance must be compared to some standard or desired level of performance. Such standards must be acquired from subject matter expert (SME) judgments for each of the task force missions and related missions of subordinate elements through platoon level, as a function of the scenarios and conditions. These standards must be expressed in measurable dimensions. They will be reviewed, revised, and approved by CATA. Figure 5 is an example of this part of the measurement system. A discussion of its components follows.

(1) Attribute: Systems theory tells us that we should analyse the quality of organizational output in terms of the organization's purpose. When we look at the doctrinal purposes of the offense or defense, we find that each purpose is expressed in terms of Mission, Enemy, Troops, Terrain and Weather, and Time (METT-T) factors. Thus we find the consideration of METT-T factors to be not only consistent with military thinking but with our theoretical base as well. Also, in the practical sense, we know that performance data from the NTC are available for analyzing these attributes.

(2) Purposes of Mission: Using doctrine from the appropriate military manuals and judgments of military experts, the primary and secondary purposes for each type of mission conducted at the NTC will be identified. Former NTC cadre members and CATA personnel, for example, could provide the military expertise while FM 71-2J would be the oasic doctrinal text. The Brigade Operations Orders (OPORD) which are on file in the ARI NTC library will also provide valuable input to this process. After determining the specific mission purposes we then will establish the standards for achievement of these purposes.

(3) Standards: This is the preeminent and most difficult task in developing the mission effectiveness measurement system. We obviously need to establish mission standards, for without them there will be no way of determining the relative merit of mission results which in turn would prevent an analysis of the strengths and weaknesses of the antecedents of those mission results. While the outcome of military missions are situationally dependent we are limiting ourselves to the NTC where the missions, scenarios, and Division Operations Plans are standardized and the terrain, OPFOR, and externally imposed stress are a relative constant. The standards must also take into account the various task force configurations and organizational equipment. These variations include mechanized versus armor task forces and units equipped with M1/M2 armor weapon systems versus M60/M113 armor systems or a combination of these. We therefore expect that mission performance standards can be established considering NTC-specific situations and consequently, the task of establishing mission standards becomes a manageable endeavor.



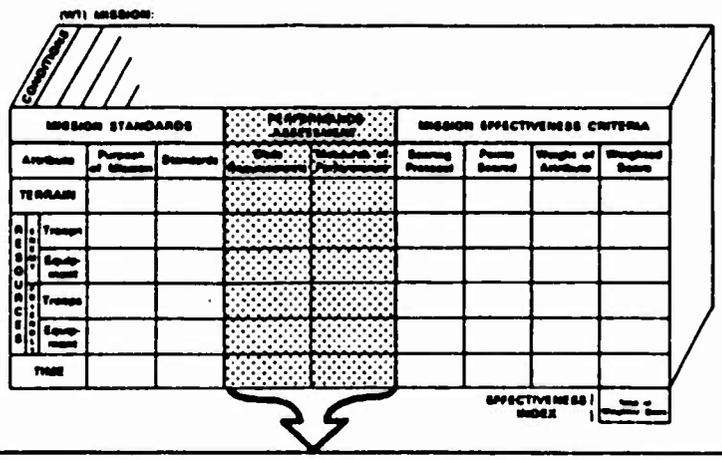
MISSION STANDARDS				
Attribute			Purposes of Mission	Standards
TERRAIN			Prevent Enemy Vehicles from Penetrating Rear Boundary.	No Enemy Vehicles Penetrate BN TF Rear Boundary (Line XXX).
RESOURCES	ENEMY	Troops	Destroy the Enemy	Inflict X % Casualties on Enemy Troops.
		Equip-ment	Destroy the Enemy	Inflict X % Destruction of Enemy Weapons Systems.
	FRIENDLY	Troops	Minimize Casualties in Order to Undertake Offense.	Suffer No More Than X % Friendly Casualties.
		Equip-ment	Minimize Loss in Order to Undertake Offense.	Suffer No More Than X % Loss of Friendly Weapons Systems.
TIME			Not Normally a Given Purpose for Defend in Sector	

Figure 5. Mission standards.

Initially, we intend to approach this task through a review of the applicable military manuals but with heavier emphasis on expert military judgments. Former Brigade Commanders of the NTC rotation brigades will be excellent sources for this information. Procedurally, we probably will need to visit with several of these military experts to develop the scope of the issues surrounding the establishment of mission standards, i.e. institutional biases, understanding of the task, ways to best approach military experts to gather the data, etc.; in other words we need to determine how to best sell the idea of establishing mission standards. Once a saleable package is developed, we can then seek consensus from military experts on mission standards through a process such as the Delphi technique. Historical NTC data will also be used to empirically establish a distribution of performance results from which actual mission results could be compared to the desired standards set by the military experts. Major deviations between the two standard setting sources will be addressed and resolved, probably through a repeated Delphi process.

Subtask 1.4: Determine measurement requirements which will result in measures of mission performance. Once the dimensions of the standards are known we will then determine the essential elements of information required to produce MOPs that possess the same metric properties of the standard so that direct comparisons can be made between them. We will be tempered in our approach by the capability of the assessment system to provide the required subjective and objective data. It must be a feasible and practical approach and the results closely coordinated with CATA. Figure 6 displays an example of this requirement. A discussion of the two components of this part of the measurement system is presented below.

(1) Data Requirements: Once the mission standards are established, the data requirements that would reliably and validly represent the dimensions of those standards will have to be established. The capabilities of the current in-place data sources will be considered as a practical matter when establishing the data requirements. These sources include digital tapes, OC judgments, MILES engagements (uninstrumented), Take Home Packages, Audio Tapes, Operation Plans, Operation Orders, and After Action Reviews. However, new data sources may also be required.



			PERFORMANCE ASSESSMENT	
Attribute			Data Requirements	Measures of Performance (MOP)
TERRAIN				
RESOURCES	ENEMY	Troops	% of Enemy Casualties: $\frac{\text{Casualties}}{\text{Personnel at Start}} \times 100 = \_\%$	Actual Mission Results Example: 43%
		Equip-ment	% of Enemy Weapons Systems Destroyed: $\frac{\text{Weapons Systems Destroyed}}{\text{Weapons Systems at Start}} \times 100 = \_\%$	Actual Mission Results Example: 76%
	FRIENDLY	Troops		
		Equip-ment		
TIME				

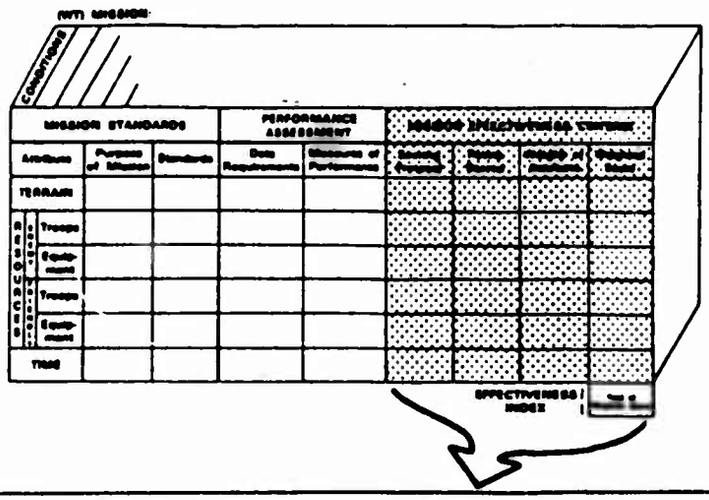
Figure 6. Performance assessment.

(2) Measures of Performance: Now that the candidate MOPs have been identified (in (1) above), the actual unit performance can be measured and recorded here.

Subtask 1.5: Design mission criterion performance effectiveness indices. At this point the effectiveness of the performance of each unit by mission can be assessed by using the measurement structure provided above, i.e., comparing the MOP with the desired standard score. This information would probably be sufficient for the military units' performance assessment efforts. However, for research purposes these data would be very unwieldly. Therefore, since these assessments will provide multiple scores based on the six or seven basic NTC missions and as many as six different standards per mission (see Attributes, Figure 4), a method will be developed to reduce these scores into a more manageable effectiveness index which would greatly facilitate the research efforts in producing correlational studies relating predictors to outcomes. Figure 7, next page, shows an example of this part of the measurement system. We cannot overly emphasize the use of this part of the system as a research tool only. Each component of the above measurement structure is discussed below.

(1) Scoring Protocol: This component of the measurement system will provide the rules for converting the results of the raw scores of the various effectiveness attributes into an effectiveness index. One way to do this would be to compare the MOP with the desired standard score. The comparative results could be obtained by placing the performance measurements on a five-point scale in which the desired standard is at the mid-point. Thus, the raw score would then be converted to a single digit which reflects the relationship of the performance to the desired standard. In this manner, the raw scores of the various effectiveness attributes (terrain, time, resources) which have differing metric properties can be standardized; also, the single digit score would be a value-based score (score based on the desired level of performance) thus allowing for relationships to be made between effectiveness as applied to a standard and its causal antecedents. After weighting the scores based on the relative importance of the effectiveness attribute to the overall mission results, the scores could be totalled to provide a single effectiveness index.

Another method for producing an effectiveness index would be to compare the MOPs for all the units thus establishing a distribution of performances which then allows for a comparison of the effectiveness of units relative to each other. This, however, would not provide an index reflective of the units performance effectiveness based on the desired level of performance. This method would entail the conversion of raw scores (MOPs) to Z-scores for each attribute; the scores are then weighted to provide initial equalization of the contribution of each attribute to the total score for each mission.



MISSION EFFECTIVENESS CRITERIA									
Attribute			Scoring Protocol (SP)					Points Scored	Weight of Attribute	Weighted Score
TERRAIN									2	
RESOURCES	ENEMY	Troops	Pts	0	1	2	3	4	1	3	3 Pts
			% Loss	0-39	40-69	70-80	81-89	90-100			
		Equip-ment	Pts	0	1	2	3	4	2	3	6 Pts
			% Loss	0-39	40-69	70-80	81-89	90-100			
	FRIENDLY	Troops								2	
		Equip-ment								2	
TIME											
									EFFECTIVENESS INDEX		Total of Weighted Scores

Figure 7. Mission effectiveness.

(2) Points Scored: This will simply be the results of applying the raw data to the scoring protocol resulting in a single digit standardized score.

(3) Weight of Attribute: We postulate that the contribution of the effectiveness attributes (terrain, resources, time) to mission results vary across missions. Thus, the relative weights of each attribute to each mission must be determined and applied to the points scored, i.e. (2) above, in order to provide the relative contribution of the attributes to the total score of each mission. The initial weights will be derived from doctrinal manuals and by military experts.

(4) Weighted Score: This will be the result of multiplying (2) and (3) above. The total of the weighted scores then becomes the effectiveness index.

Subtask 1.6: Test measurement system feasibility. CATA will be requested to collect observational data in order to test and validate the measurement system's feasibility. The results will be used to refine the system.

Subtask 1.7: Prepare technical report. The measurement model and methodology developed for its use at the NTC will be documented in a technical report.

Task 2: Development of critical task performance measurement system. In Task 1 of this research effort, the development of the mission effectiveness measurement system is being undertaken to provide a basis for determining the contribution of the NTC organizational processes to the mission results. To perform this relational study, one must be able to measure the performance of these organizational processes. That is, we postulate that in order to explain the results of the missions performed at the NTC, one must investigate the task force processes at the NTC as predictors of mission performance. This notion is shown in Figure 8.

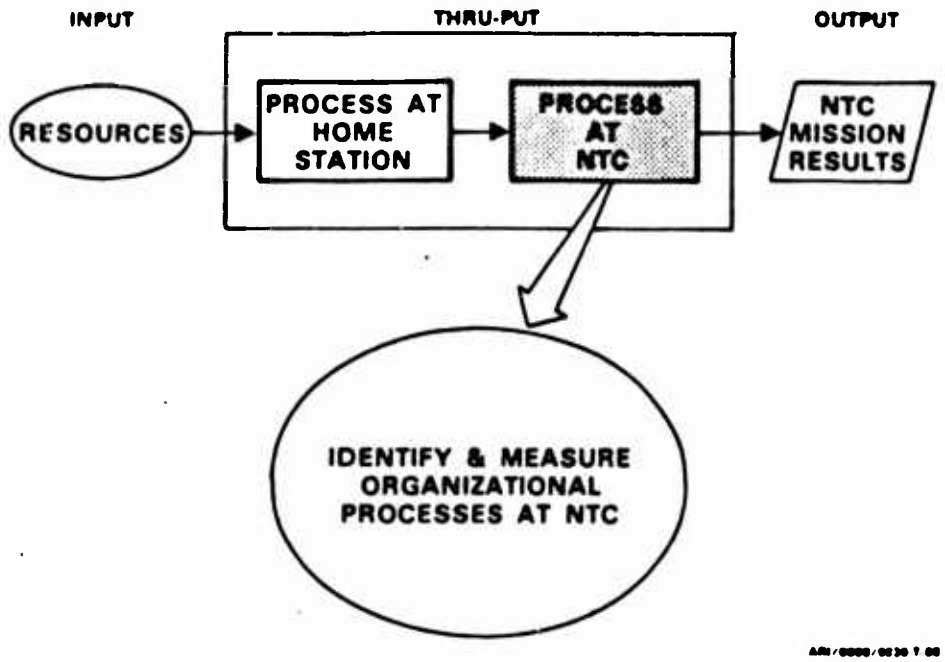


Figure 8. Measuring organizational processes at NTC.

In a sense, these factors are intermediate performance criteria (Roberts, 1980) that provide, we believe, the linkage between mission results, and home station factors. Organizational systems theory tells us that these processes would consist of unit and individual task performances as well as other factors in the broad areas of behavior and unit values. (Figure 9, next page)

In this research project we will confine our efforts to the critical individual and unit tasks. In particular, the individual tasks will include critical leadership behaviors which impact upon unit performance

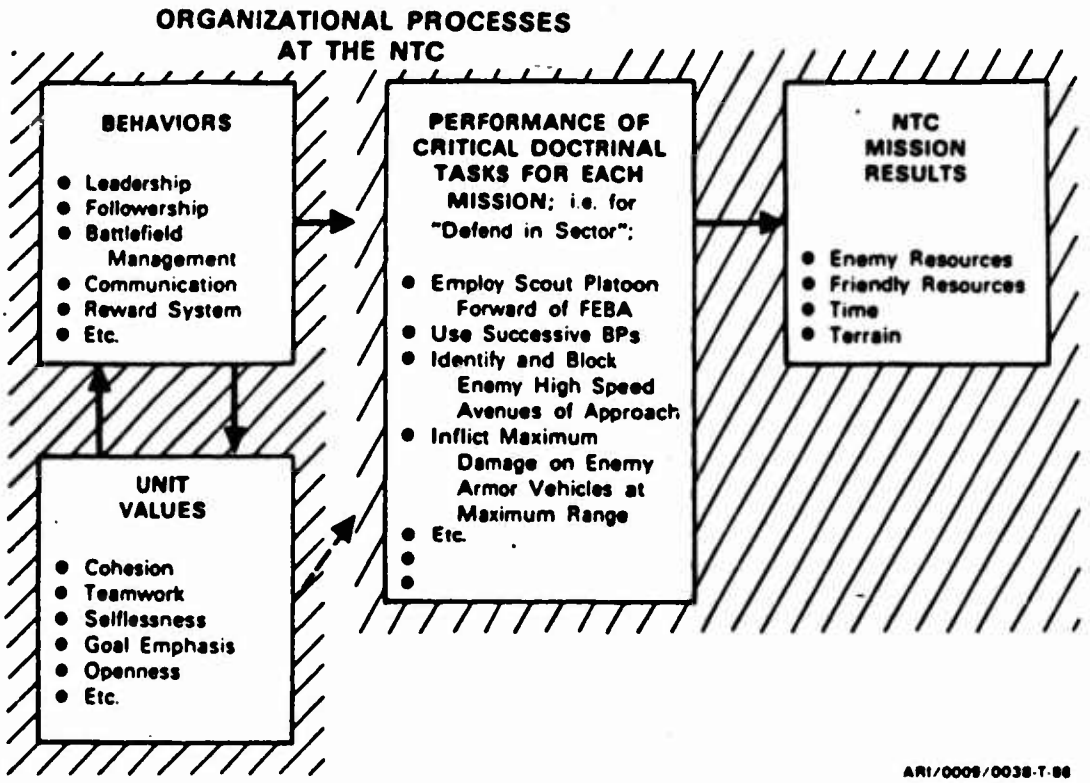


Figure 9. Organizational processes influencing mission results.

on the battlefield. (The investigation of the other behaviors and unit values and their relationship to mission results would be a logical follow-on to this study, however). These critical tasks might be called the "high-payoff" tasks which should be emphasized during periods of unit training to insure that maximum time is given to mastering those critical task skills. By developing an understanding of the relationship of task performance to the effectiveness of the overall mission, the Army can determine the critical tasks for training and units can plan training accordingly. Therefore, identifying and measuring these critical tasks will be a major effort in this study. (As an added utility, the identification of these tasks can have immediate and practical application to the NTC in the form of a specifically developed NTC-like ARTEP and observer guides which direct the observers to the ARTEP tasks with given conditions and standards. The development of these two products are discussed later in Requirement 2 of this research concept).

The methodology for fulfilling this second task is through the undertaking of the following seven subtasks:

Subtask

2.1: Develop a Measurement Model for Evaluating Critical Task Performance at the NTC.

2.2: Analyze and Identify Mission Critical Tasks for all NTC Missions from Battalion down to Platoon Level.

2.3: Establish Critical Task Conditions.

2.4: Establish Critical Task Performance Standards.

2.5: Determine Measurement Requirements which will Result in the Measures of Critical Task Performance.

2.6: Develop Critical Task Effectiveness Criterion Measures.

2.7: Prepare Technical Report.

The implementation of these subtasks are discussed next.

Subtask 2.1: Develop a measurement model for evaluating critical task performance at the NTC. In order to measure critical task performance we will first have to develop a structure or format for gathering and analyzing the data. It will be used to guide measurement development and statistical testing and will be the basis for the establishment of a relational database. This model will be a refinement of the structure shown in Figure 10, next page. It will consist essentially of three parts: Task Standards, Performance Assessment and the resultant Task Effectiveness Criteria measure. A discussion of each part follows under subtasks 2.2 through 2.6 below.

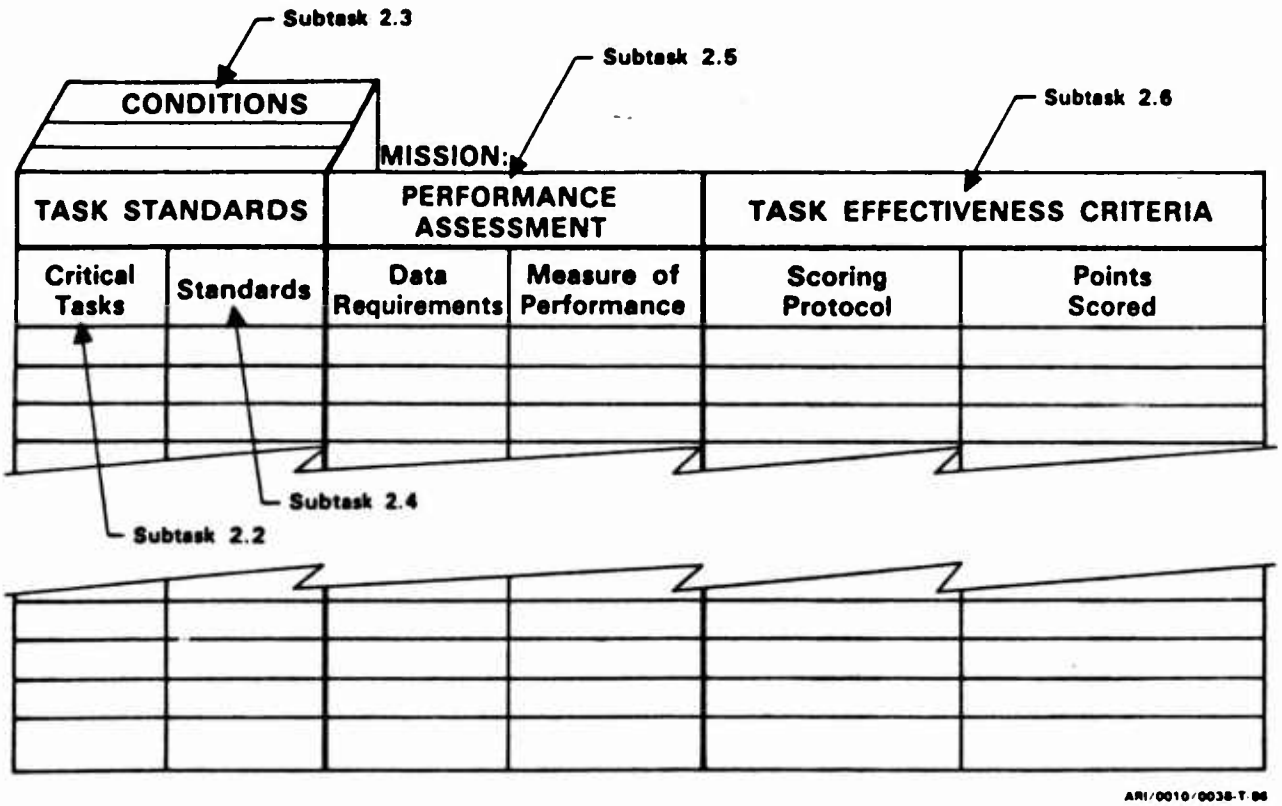


Figure 10. Critical task measurement system.

Subtask 2.2: Analyze and identify mission critical tasks for all NTC missions from battalion down to platoon level. We will first establish the constructs of the critical tasks by unit level. This effort will be the framework for identifying the critical tasks. For example, at the battalion task force level the construct may be the seven combat imperatives described in FM 71-2J which would then lead the researcher to the critical tasks which correspond to those imperatives and which affect the battalion operation as a whole. We will also establish delimitations for tasks by unit level of analysis to give uniqueness to the task levels, so as to avoid confusion or overlap between them. Thus, battalion level tasks may be those activities that generally state what the battalion should do to fulfill the combat imperatives without reference to the specific element.

We next will establish what these tasks are. As a start point, we will use appropriate doctrinal and training publications and military experts to develop a list of tasks. This will be approached from a top-down rationale. In other words, we will first establish the essential

tasks for a battalion task force undergoing the six to seven types of missions at NTC, then dendritically identify the tasks that the task force elements down to platoon level must perform in order to allow those battalion mission critical tasks to be accomplished. These critical unit tasks will also provide the context for determining critical leadership tasks. That is, each critical unit task will be examined as to the leadership tasks that will be required in order for that unit task to be accomplished.

Subtask 2.3: Establish critical task conditions. As discussed earlier under Subtask 1.2 we will be establishing the conditions which we believe will present such uniquely challenging situations to the battalion task forces that they must be considered when establishing the mission performance standards. These conditions will probably be expressed in terms of METT-T factors. Naturally, these mission-outcome oriented conditions must be considered when establishing desired critical task outcomes as they no doubt will influence the performance of those tasks. However, there will also be task conditions that must be considered. These conditions are unique to the task and may be viewed as representing the situation under which each task is to be performed. For example, in the "Defend in Sector" mission a critical battalion level unit task may be to "initiate direct fire engagements at maximum effective range with HAWs and tanks." The situational condition under which this task would be accomplished could be, "The battalion TF has occupied initial positions forward in the sector. OPFOR attacks in the battalion TF sector." The NTC scenarios and NTC SMEs will again serve as a useful informational sources for these conditions.

Subtask 2.4: Establish critical task performance standards. The standards of performance of the critical tasks must next be developed. We do not expect to have as much difficulty initially with this as with developing the standards for the mission performance measurement system (Task 1) because the doctrinal and training manuals are fairly clear as to standards of performance for critical tasks. For example, the task of engaging enemy armor at a maximum range gives the researcher a clear indication of the standard. Employing scouts forward of the FEBA is another example of a clearly worded standard (although the distance forward of the FEBA would need to be established). The conditions used for establishing the standards will be based on those conditions identified in Subtasks 1.2 and 2.3 of this research effort. As a start point, doctrinal manuals such as FMs 7-7J, 71-1J and 71-2J, will be used to establish these standards. However, we must go beyond simply "armchairing" the establishment of these standards. In addition to reviewing the doctrinal material, we must consult with the military experts who have been, or are currently, on the ground at the NTC, observing the training of the battalion task forces. Their insights gained from observing numerous unit performances should prove to be invaluable to this standard setting effort. Other SME judgments will be obtained through visits to Forts Benning and Knox. Also, in-house military expertise will be used as doctrinal resources. During the process of establishing these standards we will consider the capabilities of the present and possible future NTC data collection system to provide us with the required data elements that

reflect performance in terms of the standards' parameters. In other words, the standards must consist of data elements that can be feasibly collected. Therefore, to assist us in this endeavor, we will establish the data requirements and candidate measures of performance for each critical task. These measurement properties will also provide the basis for the development of the observer guides to be developed under Requirement 2 of this research concept. This portion of the measurement system is discussed below.

Subtask 2.5: Determine measurement requirements which will result in the measures of critical task performance. There are two basic requirements here. One is to develop the data requirements which will provide performance measures in terms of the dimensions of the standards. The second requirement is to provide the measurement system with a capability for recording the actual measure of performance.

Subtask 2.6: Develop critical task effectiveness criterion measures. This portion of the critical task measurement system is being undertaken in order to simplify the research efforts in relating the performance of the critical tasks to the mission performance criteria indices. This analytical tool will allow the researcher to reduce the multitude of performance measurements into standardized effectiveness scores which can more readily be correlated to the mission results measured under Task 1 of this research requirement. Each component of this section of the measurement system is discussed next.

(1) Scoring Protocol: We could simplify and standardize the measures by computing Z-scores for each of the measures or by establishing a five-point scale with the standard score being at the mid-point. This approach is similar to that taken in establishment of the mission effectiveness measurement system. The 5 point scale scoring protocol is more attractive than the Z-score method, however, because of the value-based meaning of the single digit score (value being a score with respect to the desired standard).

(2) Points Scored: This would simply be the results of applying the raw data to the scoring system (protocol) resulting in a single digit standardized score.

Subtask 2.7: Prepare technical report. A technical report will be prepared which documents the approach and methodology used in developing the critical task measurement system and the final results of that effort.

Requirement 2: Development of NTC-Specific ARTEP and Observer Guides.

As mentioned earlier, the development of the above performance measurement systems will allow for the construction of two by-products of those systems - an NTC-specific ARTEP and observer guides which will serve to operationalize the ARTEP as a training assessment tool. Fundamentally, these two products would be extracted from the portions of the critical task measurement system shown below in Figure 11.

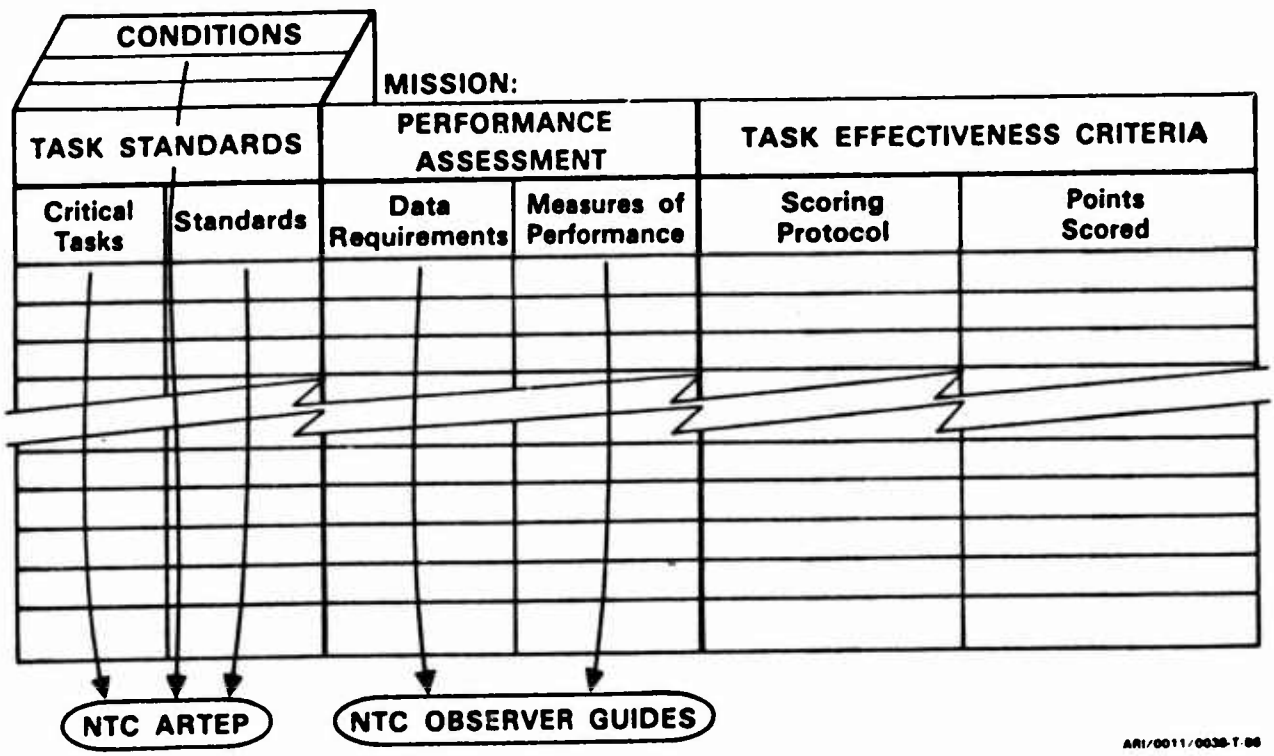


Figure 11. NTC-ARTEP and observer guides extracted from measurement system.

Task 1: Develop NTC-specific ARTEP. The most recent ARTEPs for battalion task force, company, and platoon level training will be reviewed for accuracy and completeness based on the tasks, conditions, and standards identified/developed above for the type missions conducted at the NTC. Specific gaps or potential inaccuracies will be presented to CATA for review and comment. We will also present a strawman format for an NTC-related ARTEP. Based on the CATA review comments, a draft Supplement ARTEP for the NTC will be developed incorporating information from

present ARTEPs and the tasks, conditions, standards established above. It is expected that the observational and objective data on unit performance obtainable at the NTC will permit the use of a less "procedural" format than that of the current ARTEPs (see example, Figure 12 below, extracted from ARTEP 71-2).

Based on CATA and service school final review comments, the NTC-related Supplement ARTEP will be finalized and a technical report prepared which documents the entire process and final results of the ARTEP development effort.

ARTEP 71-2

TRAINING AND EVALUATION OUTLINE

UNIT: Battalion Task Force

MISSION: Defend (3-VI-3)

TASK	CONDITIONS	STANDARDS	REFERENCES
3-VI-3-8 Defend in Sector.	The battalion TF occupies initial positions forward in the sector. OPFOR attacks in the battalion TF sector.	The battalion task force: 1. Scout platoon detects and reports attacking OPFOR elements. The scout platoon maintains contact; assists passage of the covering force, if necessary; and, on order, disengages and moves to conduct another mission. 2. Engages attacking OPFOR with supporting fires. 3. Initiates direct fire engagements at maximum effective range with HAWs and tanks. 4. Maneuvers to the flanks of OPFOR avenues of approach to obtain flanking shots.	FM 71-2, chap 5.

ARI/0012/0038-T-86

Figure 12. Sample of current ARTEP.

Task 2: Prepare observer guides. A diagnostic tool for measuring the performance of the critical tasks outlined in the ARTEP must be developed so as to operationalize the ARTEP structure developed above. This diagnostic tool will present the required assessment data, based on the ARTEP standards that the NTC Observer Controllers (OCs) can collect when assessing unit/individual performances. In essence, it will serve as an observer guide in assisting the OCs in performing their duties. It will help to insure that the observers are uniformly and consistently assessing the high-payoff activities that have the greatest impact upon unit performance. Their observations will also serve to validate the NTC-related ARTEP as a meaningful and valuable training tool.

The basis for the content of these observer guides will be the PERFORMANCE ASSESSMENT portion of the critical task measurement system. A format for displaying and recording the required evaluation data will be developed with the underlying principle that it enhances and not impedes the duties of the observers at the NTC. We will seek the advice of the NTC Operations Group in the development of these guides. CATA will review and approve these guides. Finally, the feasibility and utility of the observer guides will be tested by CATA through application at the NTC for selected issues. A report of the results of the field test of these guides will be prepared.

Determining Reliability and Validity of Measurement System.

At the end of the developmental sequence described above, a measurement system for battalion NTC mission performance will have been operationalized. The system will have been tested for its feasibility under Subtask 1.6, Requirement 1, and through the creation and utilization of observer guides under Task 2, Requirement 2. It should be noted, however, that issues of reliability and validity will still remain to be addressed.

With respect to reliability, it will be necessary to demonstrate that the observer guides and other data gathering instruments can be used in a consistent manner to gather the required data. To accomplish this, it will be necessary to conduct a field study at the NTC to collect sufficient measurements to allow for the empirical investigation and calculation of reliability coefficients. This will require designing a data collection plan that specifies the conditions and situations under which observations will be taken so that reliability estimates may be calculated appropriately.

The establishment of validity of the system involves the determination of two types of validity. The first, content validity, will largely be addressed and satisfied by a thorough documentation of the developmental procedure associated with the measurement system. The extensive use of Subject Matter Experts and doctrinal references will lend considerable credibility to the claim of content validity for the measurement system. The second, construct validity, would appear to be more relevant to the effectiveness criterion measures portion of the measurement system. The establishment of this type of validity will require empirical

investigation with independent estimates of mission effectiveness. As with the issue of reliability, a separate data collection will be required to allow for the empirical evidence of construct validity.

Thus, additional work beyond the scope of this research effort will be required to establish the reliability and construct validity of the measurement system. It is essential that this work be performed before the new measurement system is routinely used at the NTC.

SUMMARY

The purpose of this research is to develop concepts and methods for measuring and interpreting unit performance at the National Training Center. This research concept presents the approach, methodology and procedures for accomplishing this task. The milestones/personnel requirements and expected research products are also presented at APPENDIXES A and B respectively. We believe this concept will produce a measurement system that not only meets the research objectives but one which will provide distinct advantages over the present system inplace at the NTC. Figure 13, next page, capsulizes these advantages.

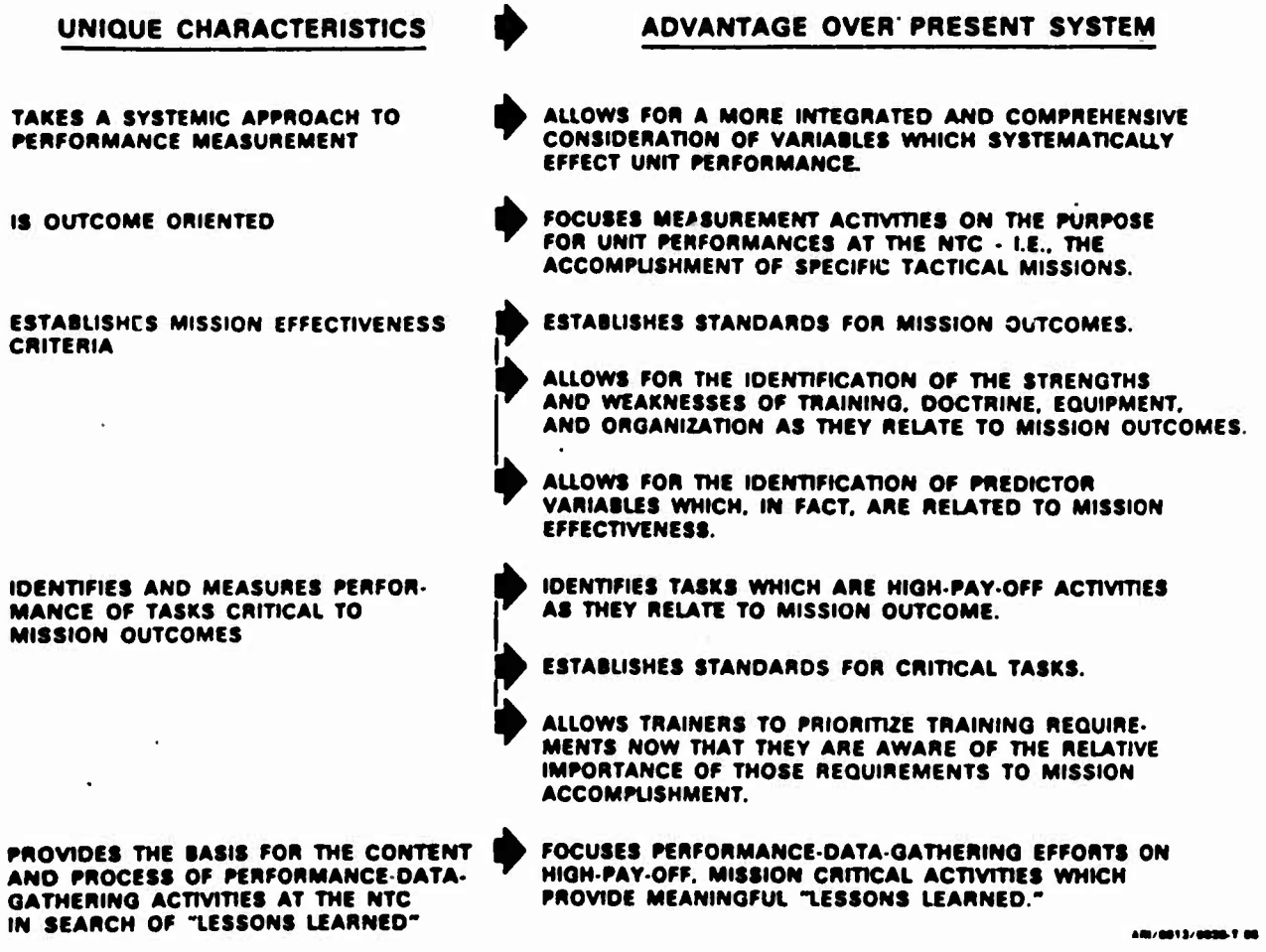


Figure 13. Advantages of proposed measurement system.

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APPENDIX A

MILESTONE CHART

MILESTONES

REQUIREMENT 1. DEVELOPMENT OF A SYSTEM FOR MEASURING AND EXPLAINING UNIT PERFORMANCE EFFECTIVENESS AT THE NTC.

Task 1: Development of Combat Mission Effectiveness Criterion Variables.
Subtasks
- 1.1: Develop Measurement Model for Evaluating Mission Results at the NTC
- 1.2: Establish Mission Performance Conditions.
- 1.3: Set Mission Performance Standards.
- 1.4: Determine Measurement Requirements which will Result in Measures of Mission Performance.
- 1.5: Design Mission Criterion Performance Effectiveness Indices.
- 1.6: Test Measurement System Feasibility.
- 1.7: Prepare Technical Report.

Personnel Resource Requirements.....

Task 2: Development of Critical Task Performance Measurement System.
Subtasks
- 2.1: Develop a Measurement Model for Evaluating Critical Task Performance at the NTC.
- 2.2: Analyze and Identify Mission Critical Tasks for all NTC Missions from Battalion down to Platoon Level.
- 2.3: Establish Critical Task Conditions.
- 2.4: Establish Critical Task Performance Standards.
- 2.5: Determine Measurement Requirements which will Result in the Measures of Critical Task Performance.
- 2.6: Develop Critical Task Effectiveness Criterion Measures.
- 2.7: Prepare Technical Report.

Personnel Resource Requirements.....

REQUIREMENT 2. DEVELOPMENT OF NTC-SPECIFIC ARTEP AND OBSERVER GUIDES.

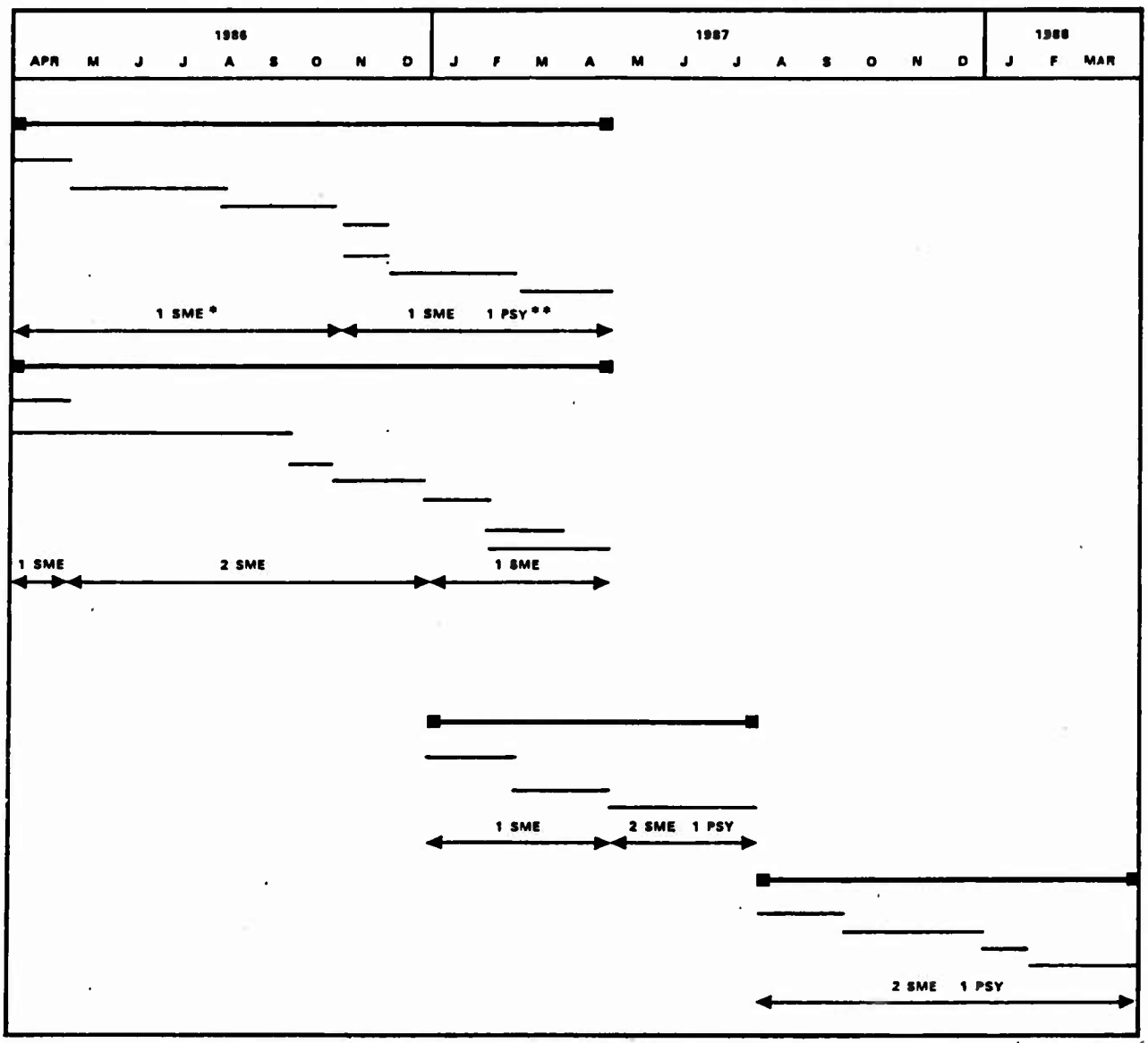
Task 1: Develop NTC-Specific ARTEP.
Subtasks
- 1.1: Identify Gaps and Potential Inaccuracies in the Present ARTEP.
- 1.2: Produce a Draft NTC-Specific ARTEP.
- 1.3: Produce Finalized NTC-Specific ARTEP

Personnel Resource Requirements.....

Task 2: Prepare Observer Guides.
Subtasks
- 2.1: Develop Format for Observer Guides.
- 2.2: Produce Draft Observer Guides.
- 2.3: Test Feasibility of Observer Guides.
- 2.4: Prepare Technical Report of the Field Test Results.

Personnel Resource Requirements.....

Figure A-1. Milestone Chart



*SME = FORMER MILITARY MEMBER WITH NTC/BATTALION TASK FORCE EXPERIENCE
**PSY = RESEARCH PSYCHOLOGIST WITH STRONG BACKGROUND IN TESTING AND MEASUREMENT

APPENDIX B

RESEARCH PRODUCTS

Listed below are the products to be produced in the accomplishment of the research requirement "Developing and Applying Concepts and Methods for Measurement and Interpretation of Unit Performance at the NTC." The products are listed in chronological order under their respective research requirements and tasks.

REQUIREMENT 1: DEVELOPMENT OF A SYSTEM FOR MEASURING AND EXPLAINING UNIT PERFORMANCE EFFECTIVENESS AT THE NTC.

TASK 1: DEVELOPMENT OF COMBAT EFFECTIVENESS CRITERIA.

Product

"A MEASUREMENT MODEL FOR EVALUATING MISSION RESULTS AT THE NTC" - Final draft due in May 86.

o Provides a structure for collecting and analyzing mission outcomes in terms of mission conditions, standards, measures of performance, and resultant effectiveness.

"PERFORMANCE CONDITIONS AT THE NTC" - Working draft due in Jul 86.

o An analysis (and identification) of performance conditions for all scenarios that are exercised at the NTC.

"ESTABLISHMENT OF MISSION PERFORMANCE STANDARDS" - Working draft due Oct 86.

o Mission performance standards will be established by presenting mission situations and conditions to SMEs and aggregating their responses, and applying consensus seeking methodology to gain group acceptance of the standards. Appropriate military doctrinal references will also be used.

"CRITERION PERFORMANCE EFFECTIVENESS INDICES" - Working draft due in Nov 86.

o Based on the unit performance measurement model, a methodology will be developed for converting performance measures into mission performance effectiveness indices.

"A STRAWMAN PERFORMANCE MEASUREMENT SYSTEM" - Working draft due in Dec 86.

o A prototype measurement system based upon previous eight-month research effort will be presented to CATA for field testing and evaluation.

"A MISSION PERFORMANCE MEASUREMENT SYSTEM FOR THE NTC" - Refined system due in Feb 87.

o Final version of the measurement system will be based on CATA field test results and comments.

"TECHNICAL REPORT ON THE MISSION PERFORMANCE MEASUREMENT SYSTEM" -Working draft due in Apr 87.

o A documented report on the mission measurement model and methodology developed for its use at the NTC.

TASK 2: DEVELOPMENT OF CRITICAL TASK PERFORMANCE MEASUREMENT SYSTEM.

Product

"A MEASUREMENT MODEL FOR EVALUATING CRITICAL TASK PERFORMANCE AT THE NTC" - Final draft due in May 86.

o Provides a structure for collecting and analyzing performance of critical mission tasks in terms of tasks, conditions, standards and resultant effectiveness.

"MISSION CRITICAL TASKS AT THE NTC" - Working draft due Sep 86.

o An analysis (and identification) of the mission critical tasks for each of the NTC missions from battalion to platoon level.

"ESTABLISHMENT OF CRITICAL TASK PERFORMANCE CONDITIONS AND STANDARDS" - Working draft due in Dec 86.

o Based on critical tasks established earlier, conditions (situations) and standards will be established by SMEs and information from appropriate doctrinal literature for each critical task.

REQUIREMENT 2: DEVELOPMENT OF NTC-SPECIFIC ARTEP AND OBSERVER GUIDES

TASK 1: DEVELOPMENT OF NTC-SPECIFIC ARTEP.

Product

"GAPS AND POTENTIAL INACCURACIES IN THE ARTEP" - Working draft due in Feb 87.

o These findings will be based upon the earlier established critical tasks, conditions, and standards for each of the NTC missions. Resolution of these discrepancies will result in an NTC unique ARTEP.

"A DRAFT SUPPLEMENT ARTEP FOR THE NTC" - Working draft due in Apr 87.

o A draft NTC Supplement for the ARTEP will be presented to CATA for evaluation and field testing. The results of the CATA evaluations will be used to produce a refined ARTEP Supplement for NTC-specific training.

"FINALIZED VERSION OF NTC-SPECIFIC ARTEP" - Final draft due in Jul 87.

o Finalized NTC-specific ARTEP will be produced based on CATA field testing and evaluation.

TASK 2: PRODUCE OBSERVER GUIDES

Product

"FORMAT FOR OBSERVER GUIDES" - Working draft due in Sep 87.

o Based on the NTC-specific ARTEP, observer guides will be prepared which will focus the OC observations on the critical ARTEP type tasks. This particular requirement will be to provide for CATA review a format for these guides.

"A STRAWMAN OBSERVER GUIDE" - Working draft due in Dec 87.

o Based on CATA review of format, above, a strawman OC observer guide will be produced for testing on selected issues.

"A TECHNICAL REPORT ON THE FIELD TEST RESULTS OF STRAWMAN OBSERVER GUIDE" - Working draft due in Mar 88.

o The strawman observer guide will be subjected to field testing and evaluation. The results will be reported in a technical report.