Study Report 97-02

NTC-CD System: Recreating the NTC Experience

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United States Army Research Institute
for the Behavioral and Social Sciences

February 1997

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

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NOTICES

REPORT DOCUMENTATION PAGE

1. REPORT DATE 1997, February	2. REPORT TYPE Final	3. DATES COVERED (from. . . to) April 1996-October 1996
4. TITLE AND SUBTITLE NTC-CD System: Recreating the NTC Experience		5a. CONTRACT OR GRANT NUMBER
		5b. PROGRAM ELEMENT NUMBER 0605803A
6. AUTHOR(S) James W. Lussier, Rex Michel, and Adela Frame (ARI)		5c. PROJECT NUMBER D730
		5d. TASK NUMBER 1131
		5e. WORK UNIT NUMBER H01
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences Fort Leavenworth Research Unit Bldg 90 Fort Leavenworth, KS 66027		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue Alexandria, VA 22333-5600		10. MONITOR ACRONYM ARI
		11. MONITOR REPORT NUMBER Study Report 97-02

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 words)*:

Past research exercises at the Fort Leavenworth Research Unit have measured battle command skills of visualization and forecasting. A highly favorable response to these exercises coupled with CD-ROM capability to vividly present combat training center battles led to the current initiative: develop multimedia prototype instructional modules aimed at facilitating battle command competencies of visualization, information assimilation, forecasting, analysis, and battle-decision making. This initiative utilizes information from observations and interviews at the Command and General Staff College's School for Command Preparation and of battle commanders and observer/controllers during National Training Center (NTC) rotations. Users are presented with NTC battles and prompted to make predictions, critiques, and other responses. The report structures synthesis of multimedia capability with battle command research to provide a CD-ROM tool that supports the developing educational needs of battle commanders.

15. SUBJECT TERMS

Battle command CD-ROM National Training Center (NCT) Multimedia
Visualization Training tool Programmed instruction

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited	41	

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NTC-CD System:
Recreating the NTC Experience

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February 1997

FOREWORD

One mission of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Fort Leavenworth Field Unit is to develop concepts to improve battle command training. ARI has joined with other programs of research and Army educational institutions such as the National Training Center (NTC), Joint Readiness Training Center (JRTC), and U.S. Army War College in an attempt to gain a better understanding of what battle command comprises. ARI-Fort Leavenworth worked with the Battle Command Battle Laboratory (BCBL) on the Battle Command Focused Rotations.

This report describes a concept for training battle commanders by using computer technology to present replays of NTC battles, while requiring the user to make predictions, critiques, and other responses. The concept calls for the presentation of a series of battle re-creations that together present concrete illustrations of battle command principles in a memorable format. The report was developed based on a BCBL study requirement in accordance with a Memorandum for Record dated 12 October 1995.

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NTC-CD SYSTEM: RECREATING THE NTC EXPERIENCE

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Fort Leavenworth Research Unit has provided support to Battle Labs in defining and measuring battle command through the Battle Command Focused Rotation initiative. The Battle Command Battle Laboratory (BCBL), located at Fort Leavenworth, KS, requested the ARI research unit at Fort Leavenworth support its battle command effort by developing a plan describing how to use technology to teach, coach, and mentor battle command on-site at field units through self-development and in Force XXI classroom environments. The Chief of Staff of the Army additionally asked how National Training Center (NCT) experiences could be exported to reserve units.

Procedure:

The Fort Leavenworth Research Unit developed a battle command training system design based on multimedia presentation of battle command situations. The system uses scenarios garnered from battles at NTC to recreate the NTC experience in CD-ROM format. This study is the design document and describes the training system and the resources needed for its construction. Descriptions of displays, navigation between displays, and types of user interaction are delineated. Emphasis is given to methods of stimulating user involvement and measuring performance. The proposed and described system is referred to as the NTC-CD system.

Past research exercises at the Fort Leavenworth Research Unit have measured battle command skills of visualization and forecasting. A highly favorable response to these exercises coupled with CD-ROM capability to vividly present combat training center battles led to the current initiative: develop multimedia prototype instructional modules aimed at facilitating battle command competencies of visualization, information assimilation, forecasting, analysis, and battle-decision making. This initiative uses information from observations and interviews at the Command and General Staff College's School for Command Preparation, of battle commanders and observer/controllers during National Training Center (NTC) rotations, and from the Battle Command Focused Rotation results. The battle command competencies of visualizing the battlefield, formulating and interpreting commander's intent, and understanding enemy intent were emphasized for analysis. The multimedia presentation of battle command situations integrates these battle command competencies to present a battle command training system.

Findings:

CD users are presented with NTC battles and prompted to make predictions, critique the actions presented, and generally describe their battlefield visualizations. The users are given feedback and scored on their performance. The study describes a walkthrough of an example

battle, indicating the flow from display to display and the characteristics for the windows that solicit information from and provide feedback to the user. Using actual battles, and especially the command net replay, creates a heightened level of interest and increased enthusiasm in the user. Tutorial prompts provide users greater explanation of doctrinal points highlighted in the battle while expert solutions integrate these and other concepts.

Utilization:

As battle command experience and research generate clear conceptions of battle command, products to train and exercise battle command skills are needed. The proposed study describes a design by which battle command competencies can be more fully developed through individual or group training and exercise. These competencies are valuable across the Army and their development may be extended beyond mechanized commanders. Footage and graphics projected for use in the NTC-CD system displays will predominately use products routinely recorded and developed for each rotation conducted at NTC. These inputs parallel those produced at other Combined Training Centers (CTCs). Once formatted, the tool would allow reiteration of many NTC or other CTC battles. The report structures synthesis of multimedia capability with battle command research to provide a CD-ROM tool that supports the developing educational needs of battle commanders and the progressive character of the field of battle command.

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Introduction

Purpose

Battlefield visualization is an extrordinarily difficult skill to master. The situation is made worse because the exercises which enable commanders to develop battle command skills are expensive undertakings, not only financially but in terms of preparation time and effort, and in number of support personnel required. For this reason, there has been a strong attempt to devise ways to use computer technology to assist officers in building battle command skills. The Battle Command Battle Laboratory (BCBL) and the Army Research Institute (ARI) are both engaged in developing methods of using technology to this end.

This paper describes a concept in which battlefield visualization is trained using CD-ROM (compact disc - read only memory) technology. The essence of the concept is that National Training Center (NTC) battles are recreated in CD-ROM format. This paper serves as a design document for building such a system.

The system which is proposed and described in this report is referred to as the NTC-CD system. The users of the NTC-CD system replay a multimedia presentation of a graduated series of NTC battles. Two major points summarize the NTC-CD system. First, it is not a game in which the users can direct the forces; rather it replays the battles as they were fought. Second, the users are involved in the process because they are required to make predictions, critiques, etc. which involve visualizing the unfolding events.

Taken as a whole, the series of battles which compose the system represent a general course in battle command and exercise the skill of battlefield visualization. To be successful, the NTC-CD system must be detailed enough to portray all major significant variables in the battle and must also be visually attractive and easily controllable to engage the users. Further, the system must tie general principles of battle command with specific concrete examples of those principles in a way which develops the ability of the users to recognize, understand, and apply the principles of battle command.

In addition to training visualization skills, the system will help officers who will be participating in exercises at the NTC learn many specifics of this general class of battle, i.e., battle command of heavy forces in the desert at levels brigade and below. They are exposed to the typical mistakes made by others at the NTC, become better prepared to avoid them, and consequently gain more from their NTC rotation.

An additional use of the system is to disseminate new doctrine, e.g., use of a weapon system with improved capability. This would entail the development of follow-on CDs of battles in which the new system was employed, illustrating its effect on tactics. Yet another use is to gauge the effects of emerging information systems by examining the how the information display in the CD-ROM affects the thought processes of the users and their ability to visualize the battles. The manner in which information is displayed in the NTC-CD system therefore must be capable of matching current and proposed display types, including those in a digitized environment.

Overview of the Report

The remainder of this introductory section amplifies some of the issues mentioned above. First, some studies identifying typical deficiencies at the NTC are reviewed. This provides the background for the problem, indicating some of the areas where performance difficulties occur. Next, battlefield visualization and other battle command competencies amenable to training by CD-ROM are described. These are the skills which should be trained by the proposed NTC-CD system so it is important to have a common understanding of them. Then, there is a brief description of some preliminary work ARI has done in presenting NTC battles which did not use computer technology to present the battles. The purpose of that work was to measure battlefield visualization skills not to train them, Nonetheless, the work provides some valuable insights into how to construct an NTC-CD system. Finally, the introductory chapter closes with a discussion of the training concept, i.e., how it is that the NTC-CD will accomplish the training of battle command skills.

The second chapter provides general design guidelines. These comprise the overall strategies to be used in designing the system. Particular emphasis is given in this chapter to the methods of involving the user. Throughout the presentation of the battles in the proposed NTC-CD system, the users are asked to make predictions, critique the actions presented, and generally describe their battlefield visualizations. The users are then given feedback and scored on their performance. These performance requirements are an important feature of the system and must be carefully prepared.

The third chapter describes the displays of the system. What types of information need to be displayed and what is the best way to display it? The displays provide the building blocks of the system and include graphic and text aspects and visual and audio components.

The fourth chapter puts the building blocks described in the previous chapter together. It provides a walk-through of a battle, indicating the flow from display to display and the characteristics for the windows which solicit information from and provide feedback to the user. This chapter contains many example scenarios drawn from NTC battles to illustrate the proposed methods.

Finally, the last chapter provides some preliminary notion of how to build the NTC-CD system. It includes who must be involved in the team, what general data is available from NTC routinely, and what will require a special effort to collect during a rotation.

Performance at the National Training Center

The Combat Training Centers (CTCs) provide some of the Army's most realistic opportunities for training battle command. Commanders are challenged to understand the battlefield, make decisions, and lead their units in an environment with many of the distractors and stresses of actual military operations. It has been noted since the early days of the NTC that many units show similar weaknesses. A 1986 report by the United States General Accounting Office reported that "recurring soldier and unit deficiencies are not being corrected," citing as deficiencies:

- Inadequate planning time is allotted to subordinate commanders.
- Units lack proficiency in conducting night operations.
- Unit commanders do not effectively use scout elements.
- Commanders do not fully integrate artillery and mortar elements into mission plans.

The report also cited positive features of the NTC such as the realism of the training and beneficial effects on the unit's home station training.

The situation today is not greatly different in both positive and negative features. Continuing difficulties in the first two items have led to changes in the structure of NTC training which now allows additional planning time between missions and a suspension of night missions. Battle commanders continue to have problems using their artillery and reconnaissance assets. In a 1994 Mounted Warfighting Battle Space Lab study, NTC observer-controllers (OCs) rated battle commander's proficiency on a scale that comprised the categories *not done*, *inadequate*, *moderately adequate*, *adequate* and *superior*. At least half the ratings were less than moderately adequate for a number of important skills as is shown in Table 1.

Battle Command Skill	**Rated Inadequate or Not Done**
Use the situation template/decision support template	86.8%
War game enemy actions (anticipate enemy actions)	84.7%
Use the situational template in COA development	74.3%
Integrate results of terrain analysis into plan	70%
Conduct physical recon of the ground	68.4%
Communicate terrain analysis to subordinates	66.7%
Conduct effective rehearsal	66.7%
Understand effects of terrain on own forces	64.1%
Avoid enemy strengths and attack enemy weaknesses	62.2%
Refine OCOKA after terrain recon	61.6%
Identify decisive points or area, times, and actions	61.5%
Analyze terrain using OCOKA	60%
Form a mental picture of the current and future state of friendly and enemy forces on the terrain in terms of time, space and purpose	59%
Modify the plan based on new estimate of enemy situation or actual effects of terrain (as necessary)	59%
Use combat information to adjust estimate of enemy situation	55.3%
Anticipate and communicate changing estimate of the enemy situation	52.8%
Conduct battlefield area evaluation	52.5%
Execute contingency plans	51.7%
Combine doctrinal methodologies with intuition, judgment, and experience	51.3%
Make timely decisions	51.3%

Table 1. Battle command skills often rated poorly by observer-controllers.

Some other questions on the same study evaluated the commander's overall ability to achieve a positive result. Generally ratings were low, for example, only 18% were rated at least *moderately adequate* on the item "achieve synchronization (mass at a critical place and time), only 24.3% were at least *moderately adequate* on "How well did the unit accomplish it's mission?" and only 15.7% were at least *moderately adequate* on "How well did the commander conserve combat power?"

The Battle Command Focused Rotation (BCFR) report (BCBL, 1995), collected and disseminated by the Battle Command Battle Laboratory at Fort Leavenworth, KS, reached similar conclusions. Weaknesses from this report following observations at the CTCs include:

- Dynamic battlefield visualization.
- Establishing and maintaining good coordination between fires and maneuver.
- Communicating key details in orders.
- Synchronizing the operation.
- Wargaming enemy actions.
- Conducting effective rehearsals.
- Developing and using Commander's Critical Information Requirements (CCIRs).
- Maintaining awareness of the situation and status of forces.

In addition some battle command strengths were noted, including:

- Maintaining a focus on the mission.
- Using the map as a visualization tool.
- FM 100-5 understanding.
- Knowledge and expertise in battlefield operating systems (BOS).
- Identifying and communicating tasks and purposes.
- Self-motivation.

Research at the CTCs has consistently highlighted the difficulties associated with practicing the art of battle command and the effect of limited training resources on performance.

Battlefield Visualization

Visualization of the battlefield is an important component in battle command. FM 100-5, Operations (CGSC, 1993) considers it a continuing requirement for commanders. In the psychological literature the term visualization generally implies the making of a mental image, usually but not necessarily, a visual image. Psychological tests of visualization focus on the visual aspect. For example, the Paper Folding Test, which is used in the Army Standardized Vocational Aptitude Battery (ASVAB), requires the participant to look at a picture of a piece of paper, mentally fold the paper several times, imagine a pencil being poked through the folded paper, mentally unfold the paper, and indicate the arrangement of holes in the now unfolded paper. Thus, visualization, as a psychological ability, involves maintaining and manipulating visual images. Another example of the study of visualization in psychology is work with chessplayers who look at a position on a board and mentally move the pieces (or play blindfold), visualizing possible future positions (Holding, 1985).

The military interpretation of the term *visualization* is broader than the psychological usage. The commander, or staff officer, may receive information from a variety of sources, for example, situation maps, radio nets, logistics charts, as well as from firsthand observation. These sources combine to make an overall understanding of militarily relevant events and their interrelationships. FM 100-5, Operations (CGSC, 1993) implies this broader meaning of the term:

> **Visualizing the battlefield is a continuing requirement for commanders. In larger tactical and operational formations, the headquarters normally is the focal point for the flow of information and the resulting planning efforts. Yet commanders of neither large nor small units can visualize the battlefield ...from a computer screen at the command post (p. 2-14).**

The remainder of the paragraph in FM 100-5 describes the importance of the commanders leaving the command post to assess the state of battle face-to-face. Aspects of command other than visualization are discussed. These include influencing the battle, exerting physical and moral presence, and imposing their will to achieve victory.

The activity described above as battlefield visualization by the military is studied by cognitive scientists within the rubric of mental models. While there is no consistent definition of what exactly a mental model is, one useful working definition is that a mental model is a task and situation-specific mental representation that supports problem-solving and decision-making in a particular context (Zacharias, Illgen, Asdigha, Yara, and Hudlicka, 1995). The creation of mental models goes beyond the psychologist's use of the term visualization; it includes images that are verbal, logical, temporal, spatial, and abstract as well as visual. For example, a commander considering the expenditure of ammunition will probably not imagine a decreasing pile of rounds, and need not use a visual image at all. The notion of battlefield visualization as the creation of a mental model is captured in the phrase "visualize the battle in time, space, and purpose" which arose at the National Training Center and is contained in the following description of visualization by the Battle Command Battle Lab (1994).

> **Visualization is the act of forming a mental picture of the current and future state based on higher commanders' intent, available information, and intuition. Seeing enemy, friendly, and terrain in terms of time, space, and purpose form the basis of the commander's estimate. While a portion of the desired future state may be dictated by a higher commander's intent, the battle commander must possess the ability to envision his organization's future state within its battlespace.**

The idea expressed by this definition is clearly the inspiration for the question in the 1994 study discussed above in which 59% of commanders were rated as inadequate or lower on the item- *Form a mental picture of the current and future state of friendly and enemy forces on the terrain in terms of time, space and purpose.*

The concept of visualizing future states implies an important aspect of mental models. Not only do mental models provide a way to organize a collection of related objects, their attributes, and their interrelationships, but mental models can also be manipulated to produce predictions of possible future states or outcomes. Thus battlefield visualization in the mental model sense implies both understanding what is happening on the battlefield and predicting what will or could happen. The notion that a mental model of a current state is operated upon to produce possible future states is clear in the definition of visualization given in the 1993 draft of FM 101-5 (DA):

> **Battlefield visualization is the process whereby the commander develops a clear understanding of his current state with relation to the enemy and**

environment, envisions a desired end state, and then visualizes the sequence of activities that will move his force from its current state to the end state.

Realization that battlefield visualizations are mental models recalls an important notion in mental model research. The mental model is constructed from both current information sources and from one's own underlying knowledge base. Similarly, a battlefield visualization is as much a product of the commander's knowledge, past experiences, and expectations, as it is a result of current information sources.

Other Battle Command Competencies

In addition to improving battlefield visualization ability, the NTC-CD system can train the user in various other battle command competencies. While battle command competencies are not as clearly specified in doctrine as leader competencies (FM 22-100, CAC, 1990), there are a large number of sources which identify such battle command competencies (TRADOC 525 Series Pamphlets, BCBL Pamphlets, and for a review see Lussier and Saxon, 1994) Since the broad definition of battlefield visualization is so encompassing, many of these skills reflect component skills of battlefield visualization.

Understanding Enemy Intent. This skill involves reading enemy actions and creating a model of enemy goals, purposes, and future actions. Not only is it important to do this well, many officers need to develop the habit of doing it at all. Often the enemy is treated in the same way as the terrain or the weather, ignoring that it is a thinking, planning entity. The enemy is wargamed to do only what is convenient or desired. For example, an enemy emplaced obstacle is treated as a natural obstacle - only as an impediment to free movement. The enemy emplaced obstacle carries an additional aspect of intent. The NTC-CD system builds skill in understanding enemy intent by explicitly requiring the users to state elements of their models of enemy action. The system further guides the users to compare their models to expert models or actual opposing force (OPFOR) intents.

Use of Assets. A recurring need is to achieve a synchronized use of assets. This can be challenging, for at each higher echelon, an expanding array of weapon and operating systems come under command. Effective use of scouts, artillery and mortar elements, air support, and engineer assets is a frequent difficulty, compounded by the requirement to integrate use of the assets with maneuver forces in a synchronized fashion. In the NTC-CD system, the users develop plans and critique the plans developed by the actual commander and staff, and thereby improve their ability to properly use and synchronize assets.

Mission Analysis. Many analytic skills can be trained with the NTC-CD system including those where OCs typically have observed deficiencies. Examples of such deficiencies taken from Table 1 include identifying and communicating decisive points or area, times, and actions, avoiding enemy strengths and attacking enemy weaknesses, integrating results of terrain analysis into the plan, and using the situational template in COA development.

Application of Doctrinal Principles. The NTC-CD system reinforces doctrinal principles and their application by emphasizing the connection between general doctrinal principles and the concrete application contained in the depicted battle. In addition the system illustrates the doctrinal principles using schematic animated sequences.

Providing Focus to the Planning and Preparation Effort. The user monitors and critiques activities such as engineer allocation, rehearsal techniques, and reacting to late arriving information. As the system depicts the unit progressing through the planning and preparation phases, the user gains skill in identifying what decisions must be made and how to make them.

Reacting to Unexpected Events. As unanticipated developments occur on the battlefield, the replay pauses and queries the user "What would you do now?" Then the system displays the commander's decision and an expert's critique of the various options. Similar probes test the user's ability to recognize and exploit opportunities and apply contingencies.

Limitations. There are several important command abilities which are not well trained by the system described in this paper. Reacting to stressors and distractors, high workload, sleep deprivation, and adverse environmental conditions are not realistically trained. The attempt to replicate invoking one's will, exerting a moral and physical presence, and motivating others would be fairly artificial. The system will not provide sufficient cues to train the skill of reading the strengths and weakness of the unit and staff. Developing the ability to display tactical patience and to think clearly in battlefield conditions is also much better trained in actual field conditions. The NTC-CD system makes no real attempt to train these skills. However, by training the analytic, visualization, doctrinal methods, system capability, time-space relationships, and thought habits, by imparting the tactics, techniques, and procedures developed at the NTC and highlighting the common errors, and by providing the surrogate experience of NTC rotations, the commanders will be better prepared to develop the difficult to train leadership skills in the field.

Display of NTC scenarios

The Tactical Commander's Development Program (TCDP) is a program of courses of the School for Command Preparation at Fort Leavenworth. It serves to prepare battalion and brigade command designees for command. In the years 1989-1990, ARI participated in the development and testing of the TCDP (Lussier & Litavec, 1992). During those years the course included an exercise to illustrate the challenges of command at the CTCs. In the exercise, the students began with a mapboard showing the locations of units during an NTC mission. They listened to 20 minutes of tape from the command radio net and attempted to visualize the locations of the units reporting. Afterward they saw an actual replay of unit movement to compare with their visualization. The battle segment used was a particularly difficult section which illustrated how easy it is to lose control of one's subordinate forces.

While the TCDP exercise was useful and stimulating, it was not possible to tell how well the participants actually could perform the visualization task. An ARI study was devised to determine if proficiency at a visualization task could be measured (Solick, Spiegel, Lussier, & Keene, in preparation). Army officers were given information from battles that had been fought at the NTC. The officers reviewed the plan and judged the probable success of the operation, then received information from the command radio net about how the battle was progressing. They were required to report on the current situation, giving a narrative account, estimating unit locations, and estimating current strength of friendly and enemy forces. They were also asked to discuss what would happen during the next hour of battle and to estimate future unit locations and strengths. Each officer reviewed one battle, pausing frequently to give judgments on current and future elements. The procedure was manually administered by a researcher. Situation updates were delivered by changing overlays on a mapboard, and posting tables of remaining strength. The officers listened to portions of the command net on a tape recorder and followed a written transcript. They responded by marking current and future locations on paper maps.

The essence of the measurement procedure is to ask the participants to provide an evaluation of a tactical situation that can be scored by comparing it to what actually happened during the training exercise. It was found that such a standardized measurement procedure could be done and, not surprisingly, some officers appeared to be better than others at making such tactical judgments. Further, it appears that some judgments are more difficult than others. Again not surprisingly, the quality of the information reported on the command net influenced the ability to visualize events accurately. Also, visualization and forecasting was more difficult for strengths or locations when they were changing rapidly than when they were not. Typically, early in attack missions (when units are crossing the line of departure and moving forward), locations are difficult to predict however strengths are accurately predicted. Later, in contact, units move less rapidly or not at all and begin to experience losses. Then strengths are difficult to predict but locations are not.

While none of the above observations is unexpected, what did surprise the researchers was the degree to which the officers became involved in the task. Each participant was required to make over fifty location and strength judgments per scenario and tactical testing was preceded by a one hour battery of mostly tedious psychological tests. Despite this, most participants seemed to enjoy the tactical task and a number gave unsolicited reports of the high value of the task for training. Two features seemed to be essential to achieve the level of involvement. First, listening to the command net was very important in bringing the experience to life, compared to simply reading an account of the battle, replaying an archived computer depiction (for example archived at the Center for Army Lessons Learned History Directorate, formerly CTC-WIN, at Fort Leavenworth, KS), or even watching a video account. The command net brought a level of detail, realism, and emotion that made the experience engaging. Second, it seemed important to require the participants to commit to specific decisions. For example, having made an exact prediction as to where the leading elements of Company A would be in 15 minutes, the participants became engaged in finding out to what extent their predictions were correct.

Training Concept

The system described in this report represents an extension of the ARI effort described in the preceding section. The two essential features found in that study, audio replay of the command net and commitment to a decision, are retained and enhanced. Instead of only a tape recorder and several overlays, the full power of multimedia format is brought to presenting the battle, retaining the pacing and storytelling aspects, and expanding scope of the account, especially in the planning and preparation phases of the battle. Also, instead of requiring numerous repeated judgments of the same type, i.e., location and strength, the range of user response is greatly increased because the primary focus is on education rather than measurement. Automation also enhances the experience by providing immediate feedback to the user responses. Finally, the system includes additional doctrinal bases, for example schematic, animated, tutorials of basic activities such as obstacle breaching and direct fire planning and thus ties the concrete activites of the depicted battles with theoretical models and battle command principles. In this way a series of battles can be combined to provide a graduated course of instruction in battle command.

There are four main ways in which the NTC-CD system improves visualization and battle command abilities:

Building a bridge between theory and practice. Officers develop a good verbal representation and general understanding of theoretical concepts and principles. For example, they know the principle that artillery must be coordinated with maneuver, and, in general, they understand this principle. At the application level, however, difficulties arise as has been found in the NTC studies discussed earlier. By highlighting the application of principles in a variety of concrete situations, the NTC-CD can teach the users how to apply theory in specific situations.

Model Enrichment. Visualization ability depends on mental models of the situation, encompassing a set of linked concepts and relationships. The NTC-CD system can enrich these models by adding new aspects to the user's existing models. For example, a user may react to a minefield by looking for a place to breach or how to bypass. The existing model focuses on procedures for circumventing the obstacle and may not automatically include a consideration of the enemy intent, i.e., why that minefield was placed where it is and what the enemy hopes to accomplish by it. The NTC-CD system can help the user to incorporate new concepts, procedures, and relationships into existing models by first evoking the user's model of the situation and then directing the user's attention to the new aspect.

Surrogate Experience. Participating in exercises is expensive. Normally officers have a limited set of battle experiences. NTC-CD can provide users with a greater and more varied set of exercise experiences.

Motivation. Learning is especially dependent on motivation, requiring both a perceived need and an engaging method of presentation. In NTC-CD, it is important that the the battles presented are real exercises rather than created scenarios. Also the involvement of the user through requiring responses creates an emotional committment that adds to learning.

The next chapter presents some general guidelines to be followed during the design of the NTC-CD system.

General Design Guidelines

Series of Battles

The initial NTC-CD system consists of a series of recreated NTC battles. It may be tempting to create scenarios and outcomes to illustrate intentional teaching points. It is better, however, to take actual NTC battles and present them as faithfully as possible. ARI research (Solick et al, in preparation) indicates that a semi-random method, for example observing 10 battles and selecting 5 for inclusion into the NTC-CD system, will provide a more than sufficient range of opportunity for illustrating battle command principles. Using actual battles, and especially the command net replay, creates a heightened level of interest in the user. Moreover, user acceptance of outcomes is increased. They are trying to predict how events actually developed rather than conform to an expert's model of battlefield dynamics.

The order of presentation of the battles is arranged to provide a battle command course that increases in difficulty and in sophistication of the principles illustrated. In addition to selecting an order of presentation that increases difficulty (e.g., defense, deliberate attack, movement to contact), level of difficulty across battles is manipulated in two other ways. First, the responses required from the user move from basic to advanced topics and are solicited in ways that lead the user to a greater or lesser degree. As an example, in an early scenario the user may be asked the leading question - "Why did the enemy place the minefield in this location?" In a later battle, the users may not be asked this question directly but will have to ask themselves this question in order to select an action that recognizes the enemy intent. Second, level of difficulty can be manipulated by restricting the information the user receives; in early battles presenting a complete as possible view of the entire battle, in later battles presenting a more restricted scope of information.

Battlefield visualization involves seeing events in one representation, e.g., a planning graphic on a map, and creating a mental representation which is not only more detailed but is dynamic, has future possibilities and contingencies, includes purposes and intents as well as just events, and includes inferences and conclusions as well as facts. The NTC-CD system can enhance battle visualization abilities by presenting more than one view of the same battlefield situation and helping the user develop the ability to shift between the views. During earlier battles in the system an attempt is made to give a good overall view, for example including ground truth OPFOR information. This matches somewhat the mental model the user or the commander must generate during the process of battlefield visualization. Later battles will restrict the presentation of friendly and enemy information to that which is normally available to a commander at the NTC. For example, at an intermediate level, OPFOR units encountered by friendly forces are depicted. At the most advanced level the picture is simply that created by the S-2 and the user must mentally generate the OPFOR image as well as more of the friendly force image based on radio traffic. In this way visualization ability is gradually challenged.

User Interaction

The user must be involved in a way that promotes the learning of battlefield visualization skills. One of the chief ways this is accomplished is by requiring the user to make responses describing, predicting, and critiquing the battle as it is depicted. Feedback on the user responses must be provided, including a numerical scoring. At the end of each battle an overall user score is provided. The major goals of the performance requirement are to involve the users more in the process, to motivate them, to focus them on the critical aspects of the situation, and to increase the impact of a comparative expert viewpoint. Secondarily, the score can serve as measurement of changes in performance. Methods and models of user interaction are considered in detail in a later chapter of this report. Here, several considerations which guide the design of user interactions are discussed.

Don't provide the user too much control. It is tempting to do so, because of the power of technology to provide freedom to explore the battle in various ways. A system designed for an analyst or planner would benefit from allowing such freedom, but in this context it would be a distraction from the main objective of battlefield visualization. The users would focus on machine operation, i.e., how to control the display, rather than on the military significance of the events unfolding. A few simple controls are adequate, e.g., toggling between unit symbols and vehicle display, changing zoom level, control over the speed of a terrain drive, and selecting tutorials when desired.

Don't let the users become too involved in their own solutions. Essentially the users are witnessing a replay of a battle planned and fought by others. At times they are asked to provide a COA or select among several COAs. At times they are asked how they would react to an unexpected event, or to select from among several alternative reactions. In these cases, there is the danger that they will become too interested in how the COA they chose or developed would have worked out. The system minimizes this natural tendency by the following procedure:

- Ask users to describe their COA
- Provide a critique and score for their COA
- Present the unit's plan or COA
- Ask them to state potential problems, predict future units locations, events, etc. of the unit's COA
- Return to the presentation.

In this way, the users become focused on how accurate their predictions are and remain interested in the displays presented, rather than the alternative proposals they developed.

The users must commit to specific decisions. It is important to have the users make the commitment and not simply form mental preferences. For example, if three COAs are presented, with persuasive arguments for each, it is not sufficient for the user to read the arguments and make a mental evaluation. He must be made to commit to a single choice which will eventually be scored. This prevents the user from becoming a passive spectator to the action.

Scoring and Feedback

Scoring will rely heavily on expert opinion, in particular on those with considerable experience at the National Training Center. Some norms can be developed by testing officers of various levels of expertise and compiling their responses. Even the most clearcut questions, such as, "How long will it take for B company to cross phase line Magnolia?" will require some degree of expert opinion on the awarding of points for accuracy. **Attempts to replace the experts with automated scoring or machine-based algorithms should not be made.** Battle command is not so cut-and-dried.

At times, self-scoring is used. That is, for example, the users make responses, are presented with a list of answers scored by experts, and decide which answers most resemble their responses, and then, score themselves. Trying to have the machine automate scoring is clumsy and will probably not work adequately in any event. Further, self-scoring is not merely an expedient. By scoring themselves the users are drawn to consider both the expert answers and their own answers and the differences between them. Self-scoring may also increase acceptance of the expert judgments, by allowing the users to take a role in their scoring.

While normally immediate feedback is most effective, in this system, feedback may be delayed. When the users have made predictions about future outcomes they must wait to see how the battle unfolds before receiving feedback and being scored.

The next chapter describes the types of displays the NTC-CD system must be capable of presenting.

Display Types

This section describes the displays and the considerations that affect their design; the following section puts the pieces together to describe a typical battle. It must be remembered that the first purpose of the displays is to tell a story and tell it in an accurate fashion. Next, the displays need to convey at least two perspectives. One must resemble the types of inputs a commander might actually see or hear, e.g., tactical maps, overlays, radio nets, execution matrixes, decision support templates, terrain views, rehearsal boards, etc. The other should convey, as well as possible, the actual battle, that is, ground truth with red and blue forces and all relevant battle entities represented. In actual operations, and during CTC rotations, the commander must be able to make the translation from the first perspective to the second. Finally, the displays must enhance the attractiveness of the overall system and thereby increase the involvement of the user.

Terrain Displays

Terrain displays on computer terminals suffer from having to trade size for resolution. Here, it is not necessary nor desirable to have the map capabilities that would be required by an analyst or planner working at a terminal. To tell the story of an NTC battle, four terrain views suffice.

Operations view. This view should be of sufficient scale to show the entire area of operations for the battalion or brigade NTC mission. The actual scale will vary depending on the mission. The goal is to show the action on one screen so that panning is not required. If the operation area is very large, one pan could be allowed which, for example would cut the view of the assembly areas when they are not necessary. For this purpose the type of terrain representations which show elevation with shading and are already available as an NTC battle replay capability work well. Figure 1 is an example.

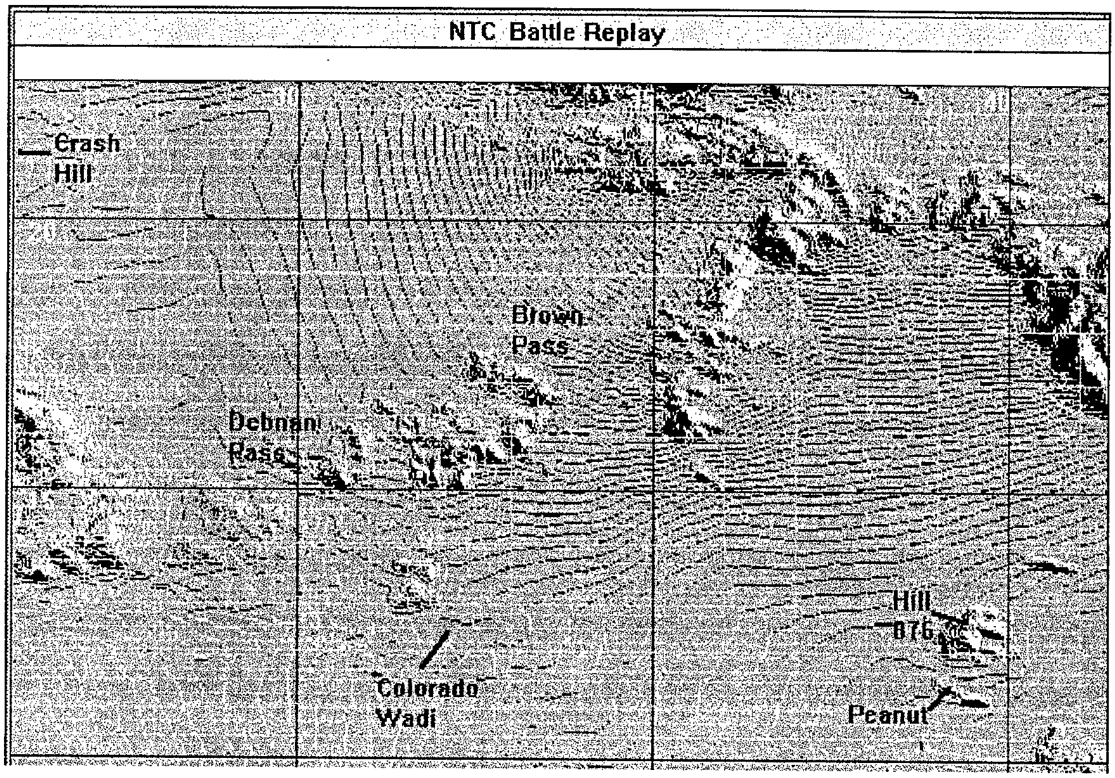


Figure 1. Northwest Central Corridor of the NTC.

Zoom View. One zoom level is required to show detail. More levels would not add capability and merely distract the user. A screen at 1:50,000 or 1:100,000 could show an area of approximately 4 by 3 kilometers and provide vehicle detail. Maps use standard Defense Mapping Agency tactical map symbology as well as the partial 3-D type of relief shown in Figure 1.

Terrain Drive. Current CD-ROM technology allows for short video segments. The user can view a two or three minute film traversing key terrain from the ground in the anticipated direction of movement.

High Angle Photographs. One or two photographs from key overlook locations would complete the set of terrain displays.

Unit Displays and Overlays

Unit Symbols. Standard unit symbols at platoon and section level are shown as indicated in Figure 2. These can be placed at leading edge, or can focus on a leader's vehicle. Friendly and OPFOR sets of symbols must be able to be displayed independently.

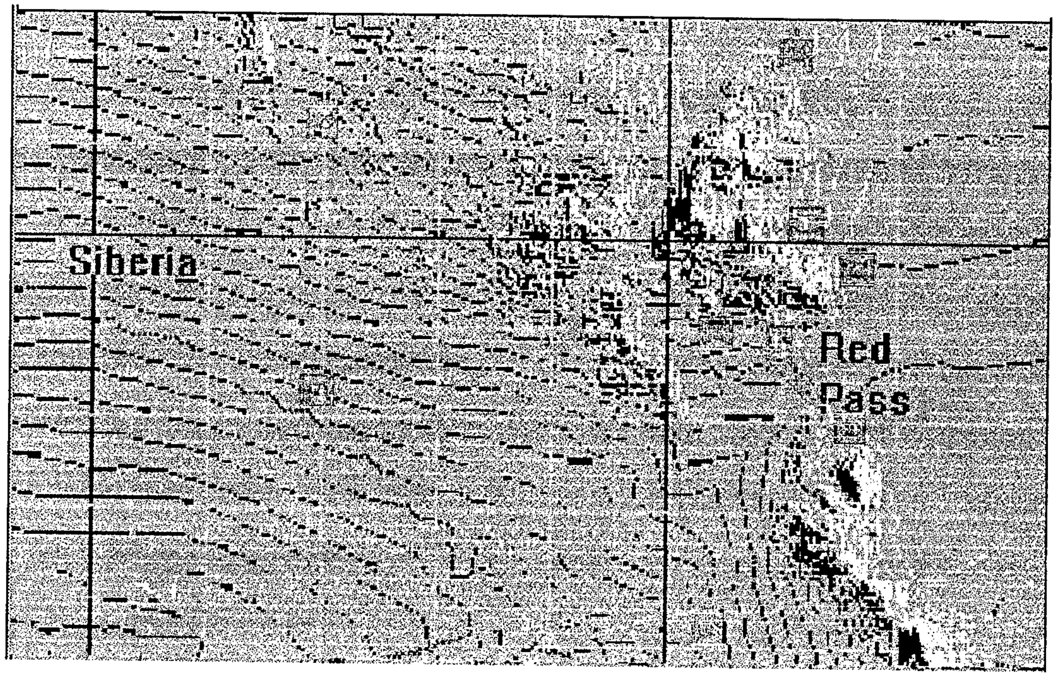


Figure 2. Unit Symbols Display.

Vehicle Displays. A display showing each vehicle as a moving dot provides a more detailed view indicating dispersion and placement of the elements. Figure 3 is an example. Changing from a view of unit symbols to vehicle locations helps promote the ability to visualize actual vehicle locations from map displays. At zoom-in map scale, each vehicle is more than a dot; standard vehicle symbols are used to identify the type of vehicle, as shown in Figure 4.

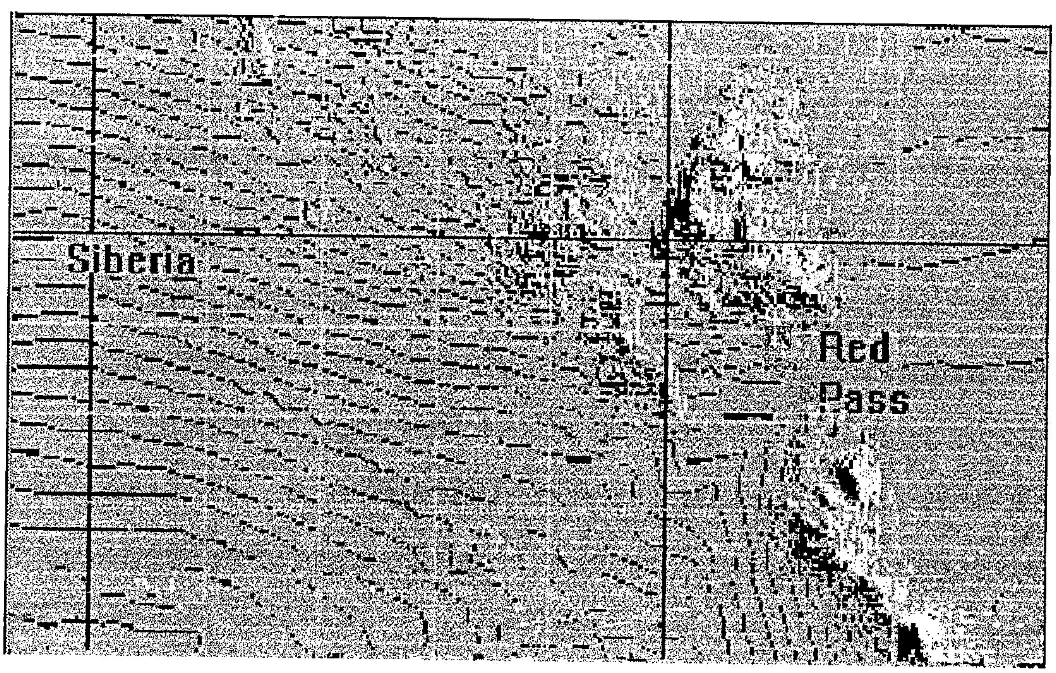


Figure 3. Vehicle Dots Display

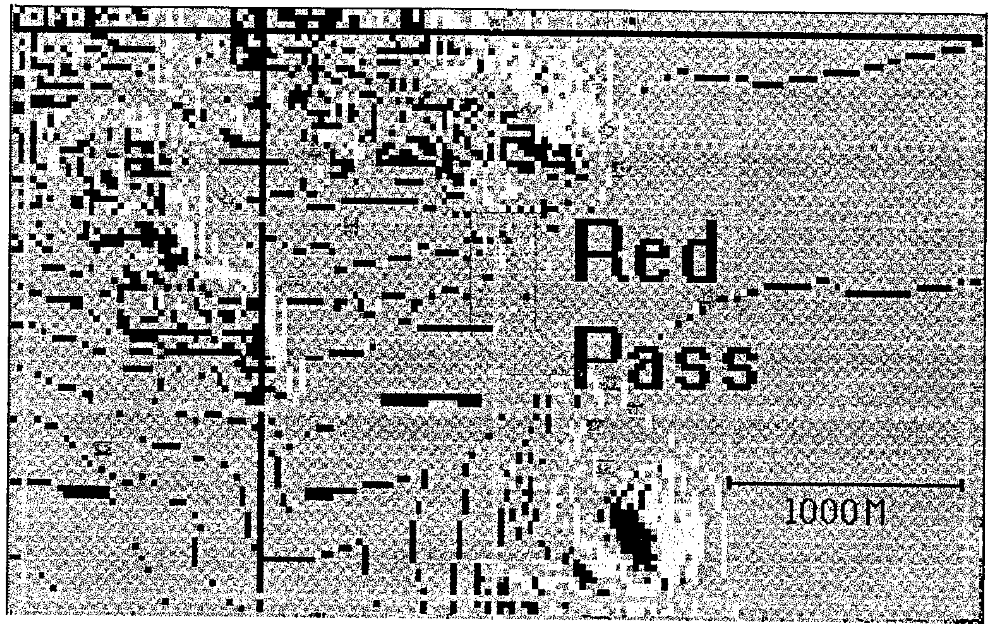


Figure 4. Vehicle Symbols Display.

Graphic Overlays. In order to display the plan and subsequent execution, graphic overlays such as the operations, fire support, intelligence, and engineer overlay are used. Figure 5 is an example.

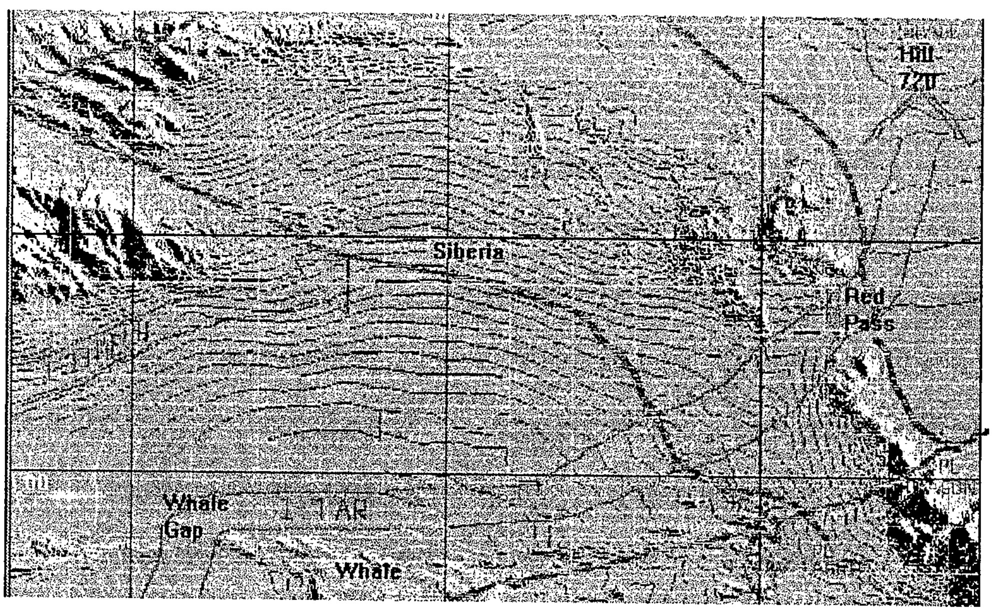


Figure 5. Graphics Overlay.

Video Displays. Some key segments of the battle are displayed as filmed from a mountaintop, as routinely recorded at the NTC. They enhance the attractiveness of the presentation as well as provide models for visualization. Additional segments show ground level views from the commander location showing battlefield visual conditions including dust, smoke, and other visual restrictors. Again, this display can be used to help make the connection between an actual visual view and a more complete representation of the battlefield situation.

Schematics

Schematics are cartoon, symbolic, or chart like displays used for a variety of purposes and can include animation.

Tutorials. The system includes animated explication of typical battle command activites showing doctrinal models of performance. Many of these are expressed in schematic form with icons and other symbols. Processes such as building an engagement area, and direct fire planning are included as user-selectable tutorials, offering brief, animated, and narrated model reviews of battle activities.

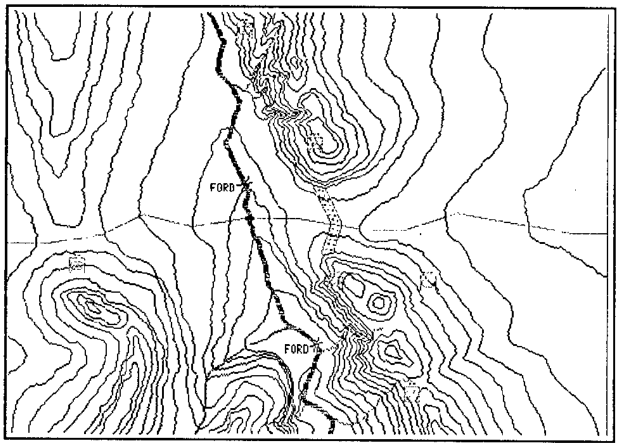


Figure 6. Breaching Tutorial: Obstacle Description

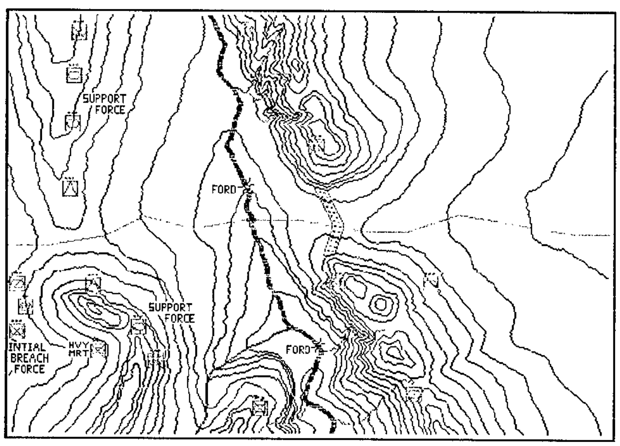


Figure 7 . Breaching Tutorial: Support Force Description.

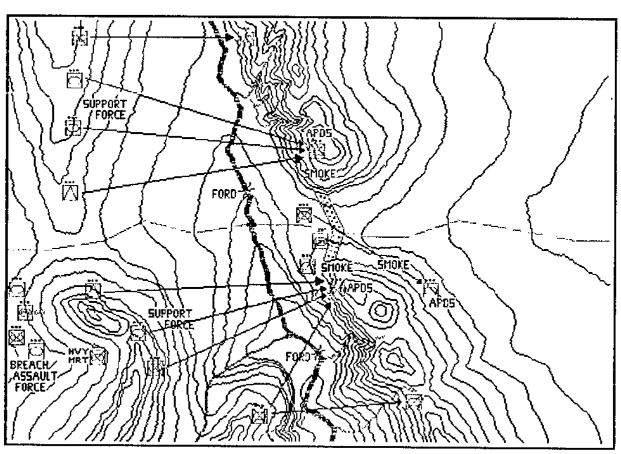


Figure 8. Breaching Tutorial: Engineer Recon Description

A tutorial on breaching operations begins with a discussion of a typical enemy defended obstacle. The narration accompanying the graphic describes the positioning of enemy scouts to screen the likely approaches, the positioning of weapons for observation and crossfires into the obstacle area, and a counterattack force to defeat the breach as indicated in Figure 6. The units being discussed are highlighted during the narration.

The tutorial proceeds with a discussion of the three elements in a breaching formation: the support by fire force, the breach force, and the assault force. After a discussion of the initial reconnaissance of the obstacle, animated graphics show the support force moving into position, as in Figure 7. The accompanying narration explains that the support force provides close, continuous overwatching fires initially to support the breaching force, and then the assault force. The narrative also explains the principles of weapons placement. Animated graphics then illustrate the forward movement of the engineer recon team from the breaching force. The narrative describes the purpose of the recon and how it should be organized. Both the animated graphics and the narrative explain how the engineer recon is covered by fires from the support force, mortars, and supporting artillery. Figure 8 captures a frame from the animated graphics.

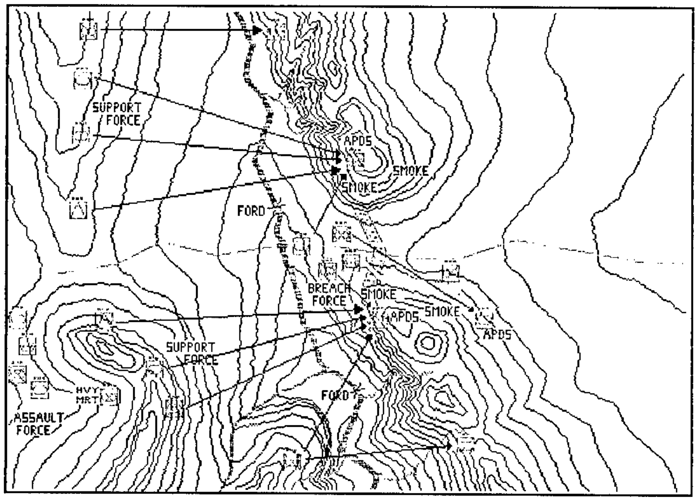


Figure 9. Breaching Tutorial: Breaching Description

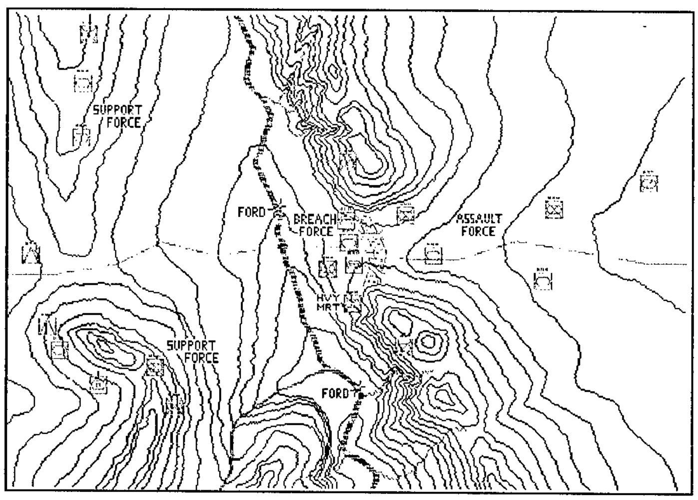


Figure 10. Breaching Tutorial: Assault Force Description.

The breaching operation itself is graphically portrayed with the forward movement of the rest of the breaching force and the cutting of lanes through the minefield as illustrated in Figure 9. The narrative describes the operation. The timing of the forward movement is discussed. The cutting and marking of the lanes are described. The supporting fires and how they are controlled are also discussed. Throughout, the animated graphics illustrate the topic under discussion.

The assault force organization and purpose are then reiterated. What they are doing and where they are during the breaching operation is highlighted. The assault force is then shown moving forward in the graphics. The timing of the movement is discussed along with its support. The narrative and the graphics describe the coordination between the breaching and assault forces. The assault force's movement through the breach and subsequent operations are illustrated and highlighted, as shown in Figure 10. The simultaneous operations of the breach force in widening the lanes and the lifting of fires and forward movement of the support force are also discussed and highlighted.

The tutorial ends with an illustrated summary of breaching operations that shows the procedure more rapidly while repeating the primary points. The tutorial is divided into segments so the user can skip and repeat segments as desired.

Preparation Activites. In addition to tutorials, schematics also help display preparation activities. The decisions a commander must make regarding priorities during the preparation phase, for example allocation of engineer assets are difficult to present. A brief schematic portrayal of preparation progress can be accompanied by queries such as:

- Where would you place your priority of effort?
- Are there lapses in preparation?
- What effects will they have during execution?

Status Displays. Other schematic displays can show relevant information regarding vehicles, fuel, and ammunition status.

Execution Events. Dynamic events during execution, e.g., shooting events, artillery, smoke, obstacle breaches, minefield explosions, etc. are shown schematically and accompanied by sound effects.

Text Displays

Radio Transcript. The NTC-CD system must have the capability to provide a transcipt of radio net messages. Unfamiliarity with the call signs and the voices of the speakers makes a transcript desirable. Also, in order to speed progress through the battle replay, it can be compressed in time by removing segments when there is no radio traffic and less important periods of the battle. A timeline on the transcript can help overcome the distortion involved in time compression. Figure 11 shows an example of a radio transcript text window. As a transmission is spoken, the text is highlighted.

0956	Alpha 6-6, This is Victor 6-6 Over.
	Hello, Victor. Talk to me.
	Got my engineers up here. I think we already made one breach with dismounts - break - . Engineers are gonna go up and widen it. - break - Got the Kilo 6-6 with me at this time. Over.
	Roger, Has he got any tanks left?
	Negative, they have been killed - all been killed. I'm trying to re-correction - I'm trying to reorganize my forces and get up there on this ridge. Over.
	Roger, good for you.
0958	Tango 6-6.
	Roger, I haven't heard Alpha 6-6 for a while. If he doesn't come back up, you're in charge up there.
	This is Alpha 6-6. I'm alive. Over.

Figure 11. Sample transcript of command net.

Plans and Orders. Text windows contain standard written material such as orders, plans, synchronization matrices and other material which supports presentation of the planning phase.

Bullet Charts. Charts with short bullet comments support presentation of major highlights, for example, when communicating commander's critical information requirements (CCIRs), and during the After-Action Review (AAR) phase.

User Performance. The system requires questions to be put to the user, responses to be received, and feedback to be presented. Much of this is done in text windows; other user interactions require a graphical interface. For example, when the users are showing where they think the units will be located after fifteen minutes of battle, they will use a point-and-click interface to move unit symbols.

Schema for a Typical Battle

This chapter presents an outline showing the flow of information presentation displays (display windows) and user response requirements (response windows) for a typical battle. An overview is presented in Figure 12. The CD-ROM system will contain a

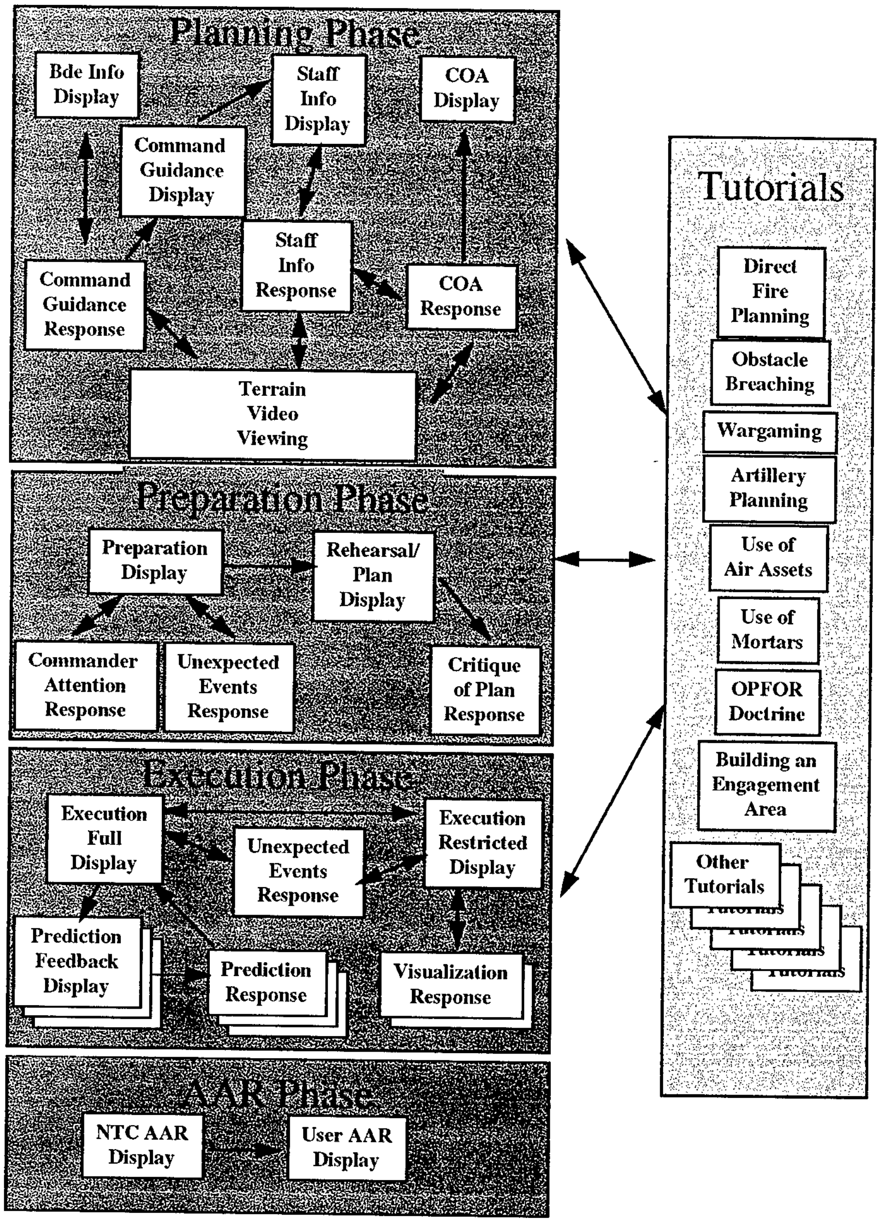


Figure 12. Flow through windows across the phases of a battle.

series of these battles, with the response requirements graduated in complexity, a single battle taking the user approximately three hours to complete.

Planning Phase

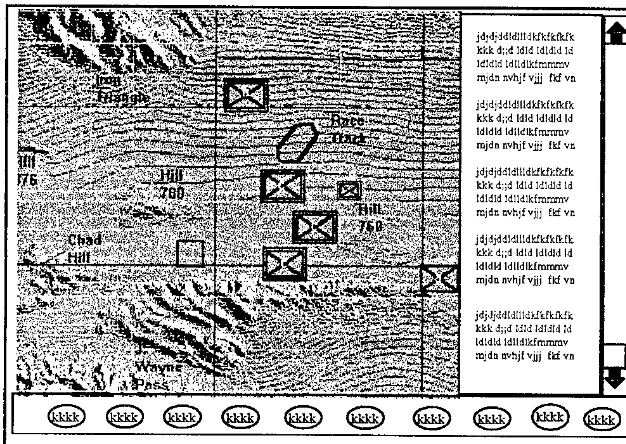


Figure 13. Initial Mission Information Screen.

Brigade Order Display Window. The user is given the brigade order with overlays, situation maps and reports, and METT-T information. The screen might look something like Figure 13 where overlays can be selected on a control panel with a scrollable text window. The user studies the information as desired, then proceeds to the commander's guidance response.

Commander's Guidance Response Window. There are two forms of response, *select from a list* and *free response*. The first is less difficult and can be used in the early battles. As the

EVALUATION OF YOUR CRITICAL ITEM SELECTIONS

YOU HAVE SELECTED: **SCORE:**

Breaching Operation Coordination 10 / 10

The key terrain for this operation is the chokepoint and enemy minefield at Red Pass. The brigade order assigns you an axis of advance through Red Pass. This limits your flexibility in avoiding a breach. The obstacle is well-defended, so precise coordination of all fires and maneuver to support the breach are critical to mission success.

Actions on the Objective 6 / 10

Although a clear understanding of the actions required on the objective are always important to mission success, for this particular mission it is relatively less important than getting there. You have been assigned an axis of advance with exposed flanks and a major, defended obstacle on the axis. Given the enemy's doctrine and his array, it is most likely that the major fight will be at the obstacle and between the obstacle and the objective rather than on the objective itself.

Fire Support Coordination 2 / 10

For this operation, brigade has choosen to maintain centralized control of all fire support not organic to your battalion. The brigade order, however, recognizes the criticality of fire support to your main effort and designates a brigade fire support coordination team to work in your TOC for planning and executing fires with the brigade, effectively taking the coordination problem out of your hands.

TOTAL SCORE: 18 / 30

The Experts Chose: Breaching Operation Coordination
Reconnaissance and Surveillance
Route Security

Figure 14. Commander's Guidance Response: Scores and Rationale.

user progresses through the series of battles the response changes to free response. For the first, the user is asked to select three items from a list of possible considerations, e.g., select three items that you would emphasize as critical in your commander's guidance. Some items are those considered as critical by most experts, some are clearly not critical, and some are intermediate, perhaps considered by experts as possible items to emphasize. During this period the user can toggle between the order information display in Figure 13, and the response list. After the user has selected three items, a list of scores and rationales are displayed, as illustrated in Figure 14. The user is given a total score indicated by the sum for the three items. Later in the course the response mode can be changed to free response where no list is given to the users. They must type three text responses into a window. After they have done so, the expert's list of possible critical factors and scores is displayed alongside the text box answer given by the user. The users must then score themselves. Throughout this phase the users can change between the information display and the commander's guidance response window, for example, to verify the rationales presented.

Commander's Guidance Display Window. After feedback on commander's guidance response is given, the commander's guidance of the actual NTC battle is presented.

Staff Information Display Window. During this portion, various staff members present estimate information. The screen predominantly displays the map with relevant overlays highlighted and a representation of the staff member speaking. The audio briefing is presented by the CD-ROM system. The user interface to this display group is similar to video cassette recorder (VCR) controls, i.e., play, rewind, fast forward, etc. An example screen is shown in Figure 15.

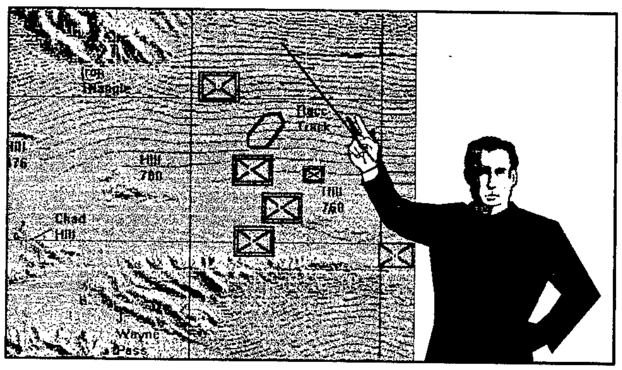
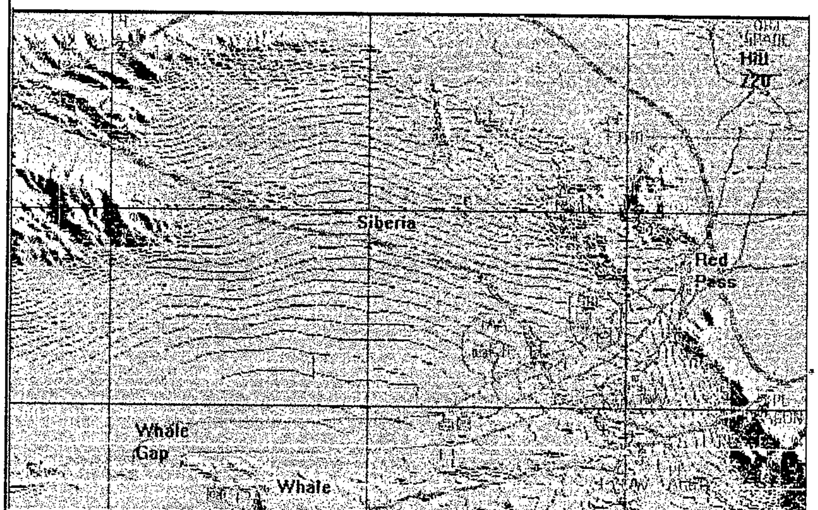


Figure 15. Staff Information Display

Staff Information Response Window. In this section the user is asked questions about the briefing. The types of questions may be very specific, e.g., *How much confidence do you have in the S-2's opinion that the OPFOR has a reverse slope defense?* Or may be general such as, *What key items of information are missing?* or, *What questions would you ask?* This section is constructed by experts assessing the actual staff briefing to probe the user for thoughts and insights an expert battle commander may have. At some points, it will be necessary to ask the user to score himself based on a scale presented. Also, the user can switch between the Staff Information Display Window and the Staff Information Response Window at will, and can return to Brigade Order Information Window as well.

Terrain Viewing Window. The user accesses a terrain viewing window as described earlier. The window contains a variable speed video terrain drive, with VCR-like controls and one or two high-angle overlooks of the battlefield terrain.

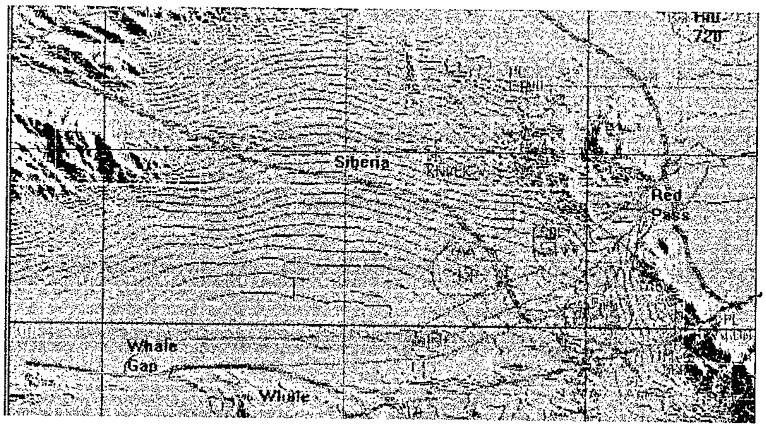
COA Response Window. In this section the user is presented with three COAs. These are developed by experts and do not necessarily have to model the COAs considered by the actual unit. Each of the 3 COAs is briefly described and is presented along with a paragraph arguing for the adoption of that COA. Of these three, one COA is not well thought out or has serious flaws, one is considered good by the experts, and the third is intermediate. For example, in one battle there may be a 10 point COA, a 6 point COA and a 2 point COA. If the weak COA is very bad it might be 0 points or if the intermediate COA is fairly good it could be 7 or 8 points. However, each COA is accompanied by an explanation that tries to convince the user that it is the proper course, i.e., a persuasive case is made. The user must select one. After selection, the expert rationale and scoring is presented. Figures 16 through 19 illustrate this concept.



DESCRIPTION: The scout platoon will lead in a route reconnaissance along Axis Dreadnought and scout enemy positions in the vicinity of Red Pass. One armored company team will follow the scouts along the axis accompanied by the Vulcan platoon and a section of mortars. At PL AGGIE they will establish a Support By Fire position to the right of the axis oriented toward Red Pass, securing the right flank. A second armored company will follow with the second section of mortars and establish a Support By Fire position on the left oriented toward Red Pass, securing the left flank. The third armored company in line will be the assault force and will have an engineer section with them. They will pull into a Tactical Assembly Area along PL AGGIE and await the passage of the breaching force. The mech company team will be the breach force accompanied by the engineer platoon (-) and will be fourth in the march order. O/O they will cross PL AGGIE and breach two lanes through the obstacle at Red Pass, the support forces lifting fire O/O. O/O the assault force will pass through the breach and establish a blocking position to secure the passage of the rest of the task force. The left SBF company will follow through the breach to lead the assault on Objective SPADE followed by the blocking company, the right SBF team, and the breaching team in order.

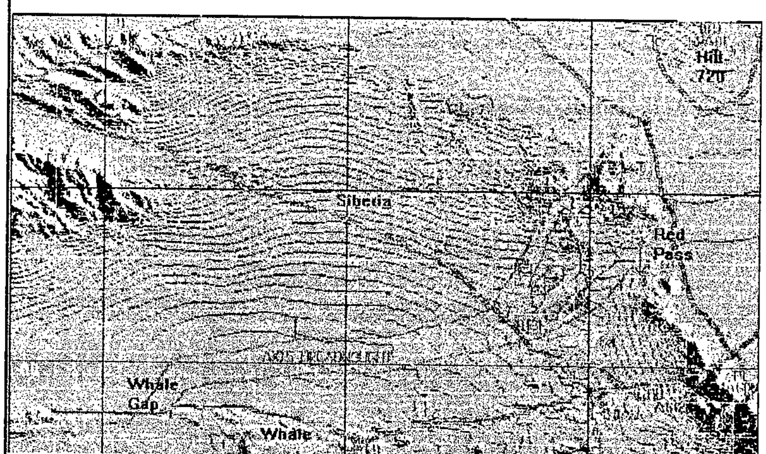
JUSTIFICATION: This course of action best meets the Brigade Commander's intent by forcing the defenders to orient south, away from 4th Brigade. It best meets doctrinal breaching operation requirements, giving maximum support to the breach, and the two SBF positions not only provide supporting fires for the breaching operation, but flank security as well. This course of action does not violate the assigned axis of advance, reducing the risk of fratracide. It also maintains the integrity of the task force, not splitting the force, and providing the best command and control.

Figure 16. Course of Action 1.



DESCRIPTION: This course of action precedes in the same manner as COA 1 in the march order and establishment of SBF and TAA positions, but the right SBF company team is also designated as the assault force and gets the engineer platoon (-). The course of action is predicated on the assumption that a successful breaching of the obstacle will cause the entire defending MRB to move south toward Red Pass to destroy our task force in detail during the vulnerable passage operations. The movement of two or all of the three rearward enemy companies south pass PL FIND will trigger the flanking movement of our two northmost tank companies. The breach and assault forces in Red Pass will set up blocking positions to hold the enemy in position while the flanking force destroys them in detail from the flank and rear and captures Objective SPADE. Coordination between the flanking force and TF 1-33 Mech will be maintained and when the flanking force crosses PL KNOCK control of all deep fires in their sector will pass to us. Should the enemy not move from their current positions, the tank company in the TAA will move into the right SBF position after the assault force moves out and assume the task of the third company through the breach IAW COA 1.
JUSTIFICATION: This course of action best responses to the most probable enemy course of action. The flanking force is afforded a rapid avenue of approach into the enemy's flank and rear that is not provided through Red Pass and avoids the frontal assault dictated by the axis of advance. The breaching/assault force has good defensible terrain on the east side of Red Pass with natural protection to its flanks. This course of action provides the best opportunity to maintain the initiative throughout the operation and maximizes the probability of fixing and destroying the enemy force in our area of operation.

Figure 17. Course of Action 2.



DESCRIPTION: This course of action has the same march order and initial taskings as COA 1, but with different Support By Fire positioning. The first company team in the line of march will move to a SBF position on the northwest shoulder of Red Pass. The second company will follow close behind and slid to the left, passing through the defile on the left to gain the high ground above the pass under cover of the fires from the first company. From this position, the second company will be able to put enfilading fires across the breadth of Red Pass and gradually advance until all positions of the enemy platoon south of the pass are under fire. The breaching and assault teams will proceed as in COA 1 and the first SBF team will follow the assault team through the breach. The second SBF company on the high ground will, O/O attack to the northeast to clear the enemy MRC currently positioned at the north of the defile and provide flanking fires for the main effort through Red Pass during the assault on Objective SPADE **JUSTIFICATION:** This course of action takes advantage of the best terrain in the vicinity of Red Pass for direct fire support of the breaching operation. By placing the SBF positions closer to the pass, on higher ground, and on the flank, they can support the breaching and assault operations throughout and force the defending MRC to retreat or be destroyed, thus reducing friendly casualties during the breach. The SBF company on the right may force the MRC north of them to enter the defile and be easily fixed during the assault on Objective SPADE.

Figure 18. Course of Action 3.

Expert Evaluation of Courses of Action

You Have Selected: **Score:** 6 / 10

COA 1: 6 points. This COA meets the Brigade Commander's intent, follows standard breaching tactics and techniques, and provides adequate security for the critical left (north) flank with the early positioning of the assault force on that flank. This COA, however, fails to consider the topography. The two SBF team locations are some 100 meters lower than Red Pass in elevation. They will not be able to provide direct fire support into Red Pass and the light breaching force will take heavy causalities without that support and risks being unable to complete the breach.

The Other Two COAs Are Rated As Follows:

COA 2: 2 points. This COA ignores the Brigade's Commander's intent. If the TF were operating independently, this would be the wisest of the three COAs, but enemy detection of the flanking movement could hold them in the north, exactly what the Brigade Commander wants to avoid. This COA also does not even follow the Brigade Commander's concept and would either result in a high risk of fratricide or cause the complete disintegration of the Brigade plan.

COA 3: 10 points. This COA meets the Brigade Commander's intent, follows sound breaching procedures, and takes advantage of the topography in the vicinity of Red Pass. There is some risk to the right (south) flank of the column which might be alleviated by giving the scouts a follow-on mission of screening the south flank and/or positioning the TAA for the assault team south of the axis.

Figure 19. COA Scoring and Rationale.

COA Display Window. The user is presented with a description of the COA selected by the unit, using displays similar to the previous combination of graphic (map and overlay), talking figure, and text and chart window. The purpose of this section is to familiarize the user with the plan. The presentation is modeled from recordings taken of the actual unit during the planning phase.

Preparation Phase

The presentation of information and user responses during this phase is dependent on what occurs to the actual unit, and what battle command lessons are available. The following ideas give an idea of how the system could tackle this phase.

Preparation Display Window. The preparation phase is difficult to display but the attempt is worthwhile. Probably the best way is with a series of snapshots, showing the state of progress at various times leading up to the beginning of execution. Elements of the presentation are made in chart form, e.g., a graph showing the progress of obstacle preparation, accompanied by a narration describing key events. Each update would be followed by some form of user response requirement.

Commander Attention Response Window. One method of soliciting responses during the preparation phase is to ask about where the user thinks the commander should focus attention. The format is similar to that used for commander's guidance display window. The user is presented with a list of possible activities such as, supervise maintenence, check progress of survivability positions, check subordinate understanding, etc. The user selects and is scored based on expert opinion.

Reaction to Unexpected Events Response Window. Again this will depend on events the unit experienced. The user is presented with decisions faced by the commander, given options, and forced to select a decision. An example sequence of user interaction is illustrated by Figure 20. The actual presentation would combine text, animated graphics, speech, etc., as appropriate.

S-2: There is a persistent agent placed directly on our axis of advance at this location. S-3: The scouts left two hours ago.
What are your options? List major options here.
List of expert generated options 1. Button up and stay with the plan. 2. Swing to the south around the contaminated area then back onto axis of advance. 3. Abandon the COA and choose other axis of advance. Select one of the options. Expert Evaluation of Options 1. 2 points. Attrition will be too great trying to advance through ... 2. 4 points. This will probably bring us into enemy kill sack. 3. 10 points. Even though scout activity may be uncoordinated, enemy expects us to take northern avenue of approach and therefore...
What was OPFOR's purpose in contaminating area?
Type answer in window Score your answer by comparing with expert evaluation of possible OPFOR reasons.

Figure 20. Sequence of user interaction in reacting to unexpected event.

A more detailed example is illustrated by Figures 21 and 22. The current enemy situation display appears on the screen with narration indicating that the enemy has fallen for the deception and moved the motorized rifle battalion (MRB) forward to meet the anticipated attack of 1-33 Mech. Further narration indicates that division has taken a company from 1-33 Mech to act as their tactical control force (TCF) and now 1-33 has only two effective companies for their supporting attack. The user is then asked how these events might affect their task force (1-7 AR) mission and what options they think are available to them to respond to these events. After they respond, a list of expert-generated options appears on the screen and they are asked to select the one they think is best. Following the selection, the experts'

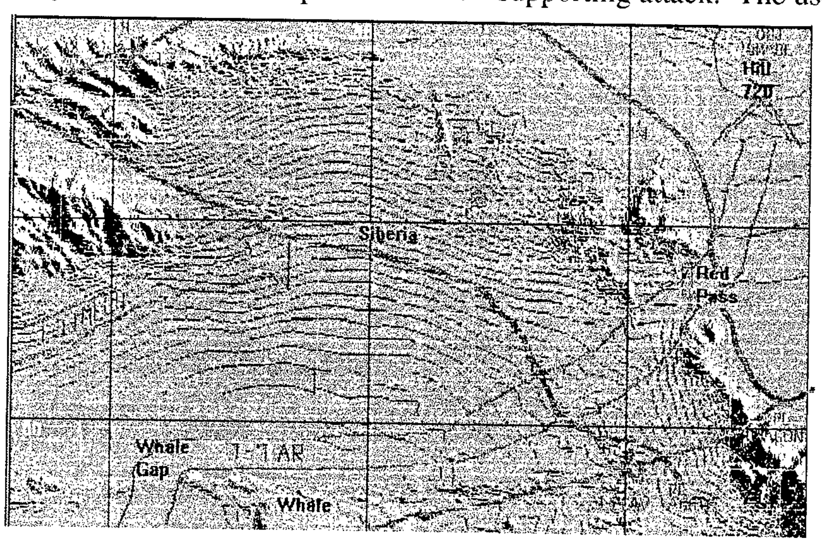


Figure 21. Graphic Example of Preparation Phase Unexpected Event.

evaluation of the options appears, including a score for each option and the rationale for the score. Following this, the enemy situation overlay from Figure 21 reappears on the screen and the user is asked to move the enemy units to indicate how they think the enemy would react to our attack through Red Pass. An overlay showing the experts' prediction of the enemy reaction then appears on the screen along with the user's prediction for comparison. Figure 22 is an indication of how this comparison graphic might appear, with the user's prediction in yellow.

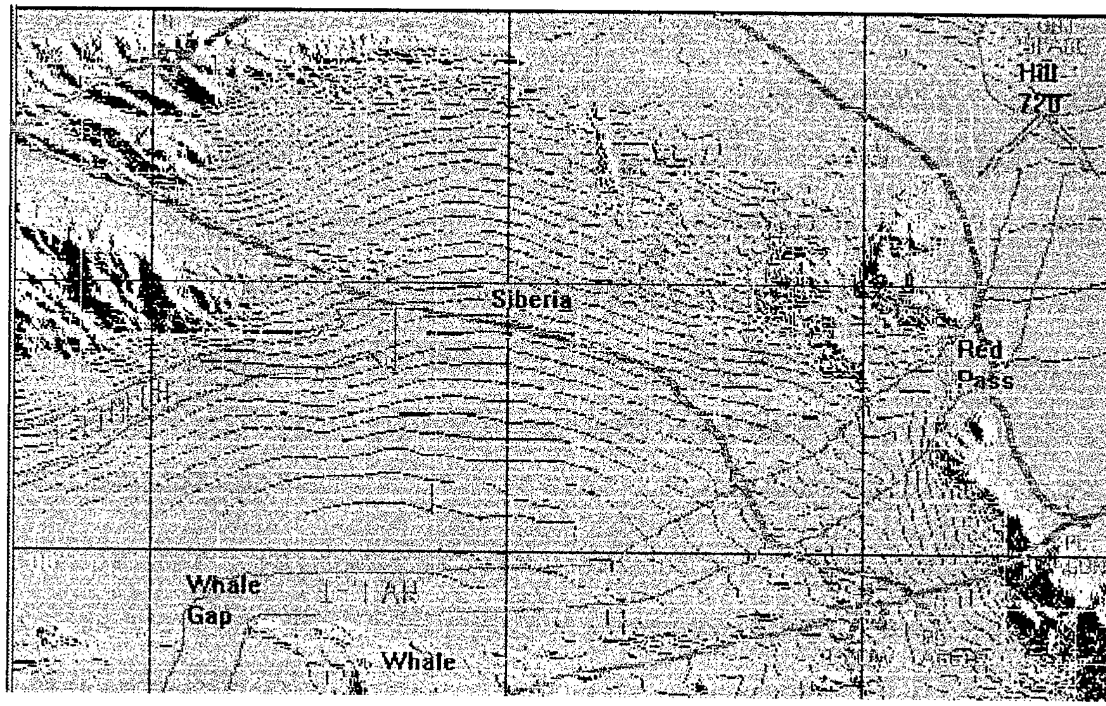


Figure 22. Comparison of Predictions.

Rehearsal/Plan Display Window. The NTC-CD system is not particularly well suited for instructing rehearsal techniques. The rehearsal, however, is shown in order to present details of the plan. Events depicted at the rehearsal may be summarized using animation on a map background. The user responds not so much to the effectiveness of the rehearsal rather to the synchronization and/or potential problems in the depicted plan. This most directly targets the user's battlefield visualization abilities. The rehearsal depiction is accompanied by a display of the unit generated products such as the synchronization matrix, the decision support template, execution matrix, operations order, and operating system overlays.

Critique of Plan Response Window. Here, the user gives an overall critique of the plan, estimates likelihood of success, and attempts to identify the major events that will occur during execution. How will the plan really unfold? Scoring of this response will be delayed until after the execution phase is displayed, but will be user scored based on an expert generated model.

Execution Phase

Execution Full Display Window. Presentation of the execution phase is more straightforward than either the planning or preparation phase. Essentially a graphic display is shown as command net traffic is heard. A transcript window is presented at the side and the active part of the transcript is highlighted, for example, by color. The user has some relatively simple controls, such as two levels of resolution, unit symbols versus vehicle marks, and toggles to turn the various overlays on and off. Time can be compressed as indicated earlier.

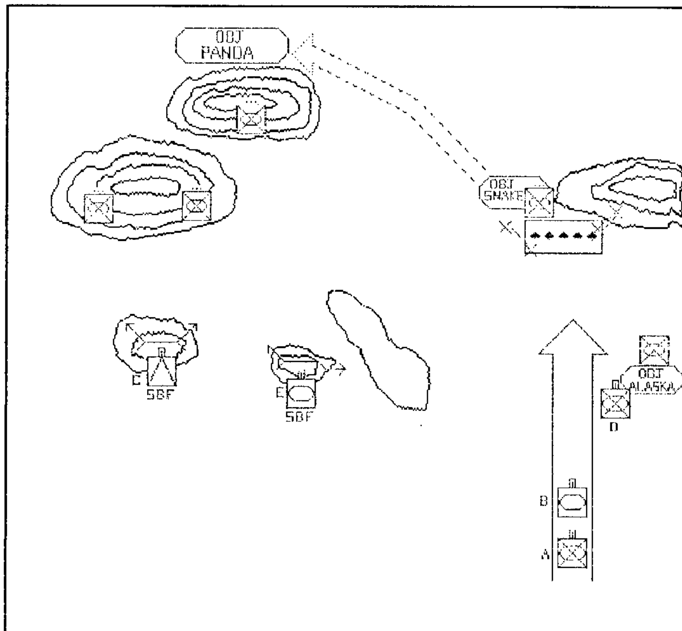
Prediction Response Window. Prediction responses are straightforward measurements of the user's ability to anticipate future developments, and knowledge of time-space relationships. The battle replay is paused and the user is asked to describe "What will the battlefield look like in 15 minutes? In 30 minutes? The user responds by dragging unit symbols with a mouse and setting levels of strength, perhaps with a slidebar. In addition to this graphical interface the user is asked to briefly state rationales for his predictions, such as "The engineers will slow A Company down," "The exposed position of B Company in their support-by-fire-position will cause them to take heavy casualties in the next 15 minutes," "The attacking unit is approaching the barrier but there is no suppression of enemy artillery nor obscuration of the units approach so they will suffer heavy attrition." Scoring of prediction is based partly on how accurate the predictions are and partly on subjective expert judgment, because some predictions are more difficult than others and sometimes unlikely events happen.

Prediction Feedback Window. After a prediction is made, the user watches the battle unfold. When the replay reaches the time corresponding to the end of the prediction, the user receives a feedback window comparing actual events with the predictions. After this, the user is required to make a new set of predictions.

Execution Restricted Display Window. At selected segments of the battle, the full graphic display of the operation is withheld and replaced by actual video view from the commander vehicle. During these segments the user receives only that information that the actual commander would receive, except for the command net transcript.

Visualization Response Window. When the battle is paused from a restricted display window, the user is asked to state the current locations of units and their current strengths. The collection and scoring of the user response is similar to that of the prediction response but instead of predicting future events, the user is describing what just happened in the battle. Feedback for the visualization is immediate.

Reaction to Unexpected Events Response Window. This has the same format as the similar response category during the preparation phase. The replay is stopped at a critical decision and the user is asked to generate options and then decide. An example is shown in Figures 23 through 25.



Commander's Intent

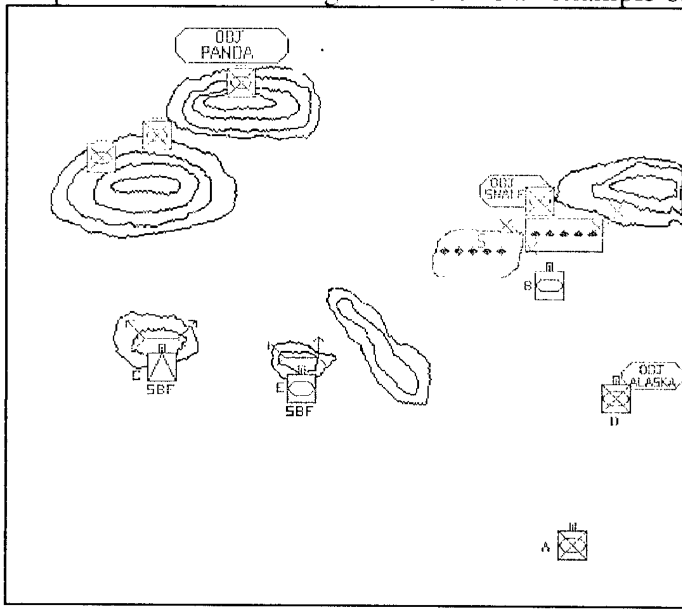
Purpose: Cause collapse of defensive belt by penetration at OBJ SNAKE.
Method: Isolate a single platoon on enemy flank and destroy it with direct and indirect fires.
Endstate: Enemy's defensive belt collapsed. TF on OBJ PANDA with at least two company teams.

Scheme of Maneuver

Two teams move to SBF positions to suppress enemy fires. Delta Mech destroys an enemy CSOP on OBJ ALASKA. Bravo Tank breaches the obstacle. Alpha Mech (main effort) passes thru and destroys enemy platoon on OBJ SNAKE. O/O, other teams pass thru breach and seize OBJ PANDA.

Figure 23. Unexpected Event: The Plan.

Figure 23 illustrates the original plan of the operation. Assume an event, unanticipated in the plan has occurred. Figure 24 shows an example of such an event.



Execution

C and E teams occupied their SBF positions, but D team had the smoke plt with them. Unobscured, C and E were pounded by artillery.
High ground inbetween prevented them from supporting D, who was heavily attrited by the CSOP and by fires from OBJ SNAKE.
S-2 templated enemy in forward slope defense; they proved to be reverse slope and were unaffected by our artillery fires.
B team was brought up and has run into a FASCAM minefield not anticipated. They are taking heavy fire from OBJ SNAKE plus indirect.

Figure 24. Unexpected Event: The Event.

The user may be asked leading questions. Why do you think the enemy layed in this additional FASCAM minefield? The user is asked to identify the options open to them given the unexpected event. Once the user has done this, a window is brought up showing the expert-generated options, as in Figure 25.

Expert Evaluation of the Options

1. 4 points. Without additional fire support, Bravo Team will suffer unacceptable attrition and may not be able to complete the breach.

2. 10 points. This option should provide the additional fire support needed by Bravo Team to complete the breach and avoid the expected enemy kill sack set up to the left of the FASCAM minefield.

3. 2 points. This would seem to be the expedient thing to do, but most likely plays into the enemy's hand. It is most likely that the enemy layed-in the FASCAM minefield in hopes of further channelizing the Task Force into a likely kill sack between the minefield and the high ground to the southwest.

Figure 25. Expert Evaluation of Options

AAR Phase

NTC AAR Display Window. In order to gain closure a brief reenactment of the main points of the NTC AAR is given, with a voice narration and briefing slides, switching to graphics and animation as appropriate. Figure 26 contains some representative AAR comments for the battle used above as an example.

What the Task Force Did

Faced with an unanticipated threat, Bravo Team commander attempted to bypass the minefield to the west as in option 3 and the Task Force commander had Alpha Team follow him. Bravo Team drove through the kill sack and was rendered combat ineffective. Alpha Team followed and remnants actually reached the objective, but the team was ultimately destroyed by flanking fire from the enemy reverse slope platoons to their left and the enemy battalion's reserve. At the end of the mission, the TF had lost 22 of 23 M1s and 30 of 36 M2/M3s.

Why They Failed

Bravo Commander failed to:	Visualize enemy purpose and TF Commander's intent.
	Take into account kill sack templated by the S-2.
	Take into account weak point in obstacle belt IDed by TF Commander.
SBF Commanders failed to:	Understand intent of their mission--accomplished task, but not purpose.
TF S-2 failed to:	Take into account strong intel from Brigade regarding reverse slope defense.
TF Commander failed to:	Control his breach company--too involved in direct firefight.
	Maintain the mission perspective.
	Correct failures in support of breach before bringing up breach team.
TF staff failed to:	Adequately consider actions beyond the breach in their planning--no follow-on missions for SBF teams, no security for flanks of penetration.
	Consider the total enemy picture in judging the basic assumption that destruction of one platoon would cause enemy defense to collapse.
	Follow doctrine in breach planning--no smoke, artillery, or direct fire available to directly support the breach.
	Plot contour lines to see if SBF teams had LOS on Objectives ALASKA and SNAKE.

Figure 26. Summary of AAR Points

User AAR Display Window. A summary of the user response and scoring is given, overall user performance is compared against a normative group, and the user performance is categorized. This final section provides feedback to the user on his overall performance and score.

Building the Software CD

Given the animation, video, and extensive graphics to be presented to the user, compact disk is a cost effective medium for recording this multimedia presentation. Two elements are required; the software shell which structures the battle scenario inputs and gives the system the capability to present different battles, and the battle inputs for each battle scenario.

Software Structure

The most cost-effective software shell would be based on the NTC Operations Center's applications and display systems. Such an approach has several advantages. First, it greatly reduces the cost of building the shell as the bulk of the software is already in use. Second, the displays that are generated in the NTC-CD system will be those of the NTC Operations Center system, giving it nearly perfect fidelity. Third, the battle data inputs to the NTC-CD will, in large measure, be products of the NTC Operations Center, thus assuring compatibility and minimal effort in battle data entry.

After the NTC-CD requirements are conceptualized, a feasibility study must be done. The study will determine what display and application software might be "lifted" from the NTC Operations Center, what might be transferred with modification, what must be taken from other government sources, and what must be developed from scratch. For example, terrain displays recorded during the NTC battles by the Operations Center typically exhibit individual dismounted troops, wheeled vehicles, tanks, and fighting vehicles. By identifying an element of each unit (i.e., the lead element or command element and the second in command as a backup), the element can have a standard military unit symbol attached to it on the screen. The display then represents units instead of vehicles. This application would become part of the NTC-CD system.

The resulting software shell must be capable of generating the types of displays and user interactions described in this document. It must guide the author through the process of translating NTC-generated battle data into NTC-CD practice scenarios. It must impose the sequential presentation structure described in Figure 11. It must permit a sufficient variety of user interactions to coax different types and levels of insights out of the user as discussed in this document. It must be able to compile user scores from various software routines. It must also be able to synchronize narration and sound with animated graphic displays. Also, tutorials are contained in a library as part of the shell. Battles may include links to specific relevant tutorials.

Entry of inputs for development of subsequent training CDs must be easily supported by the structure and allow relatively simple and rapid entry of other battles. Although the system is discussed as an NTC system, the shell must support the future inclusion of battles from other CTCs. Professionals required to support shell development will include at a minimum an instruction system designer, a software engineer, and military experts with NTC background.

Battle Data Input

Much of the footage and graphics projected for use in the NTC-CD system displays will use products routinely recorded and developed for each rotation conducted at the NTC. Terrain displays to include true unit and vehicle locations as well as unit developed overlays and templates are regularly produced at the NTC Operations Center ("Star Wars Building"). Many unit developed products such as overlays and templates are converted to digital format and recorded by Operations Center personnel. These include operations, fire support, intelligence, and engineer overlays. What the player unit provides to the Operations Center is drawn over the computer map and then saved as a filter for future use during the AAR.

Some inputs collected by NTC personnel may have to be redone or modified for input to NTC-CD if higher quality is required. High angle photography as well as leader's reconnaissance video of the battle space is normally filmed. Command net transmissions, unit orders and AARs are also normally recorded by NTC personnel. All battle related inputs (i.e. video, radio transmissions, computer displays) must indicate real time for accurate editing and synchronization. Other video collected may show unit personnel in an identifiable manner and therefore will not be directly used in the NTC-CD to protect anonymity. Such material, however, can still be valuable to NTC-CD system developers in understanding the event to be reconstructed.

While much of the necessary input can be taken from that which is routinely gathered by NTC personnel, some information must be collected by the NTC-CD system development team. Video recordings of command guidance, planning, wargaming, and rehearsal events, supplemented by observer notes, can be used to construct the planning and preparation phases of the battle depiction. Good documentation of the planning and prepartation phases will greatly ease reconstruction of these phases. Video footage of the battle corridor from a ground perspective must be made for the terrain used in the battles. Finally, the NTC-CD system requires video of execution from the command perspective, illustrating the commander's viewpoint on the battlefield and showing battlefield visual conditions. This requires a special collection effort.

Professionals needed to support and direct information gathering will include analysts and subject matter experts with NTC experience. Among other activities they collect judgments and discussions provided by OCs and Operations Center staff. These are integrated with doctrine to support development of questions, prompts and scoring of the user. Computer technicians, and camerapersons will also assist in the data gathering. Further video crews as well as Operations Center instrumentation staff may be coordinated through NTC to support the development and gathering of battle data inputs for the NTC-CD system.

A test run NTC-CD can be produced locally at Fort Leavenworth by accessing the CTC archives in tandem with regularly run JANUS NTC scenarios at the School for Command Preparation's Tactical Commanders' Development Course and Battle

Commanders' Development Course. Such a test will provide an opportunity to prepare for data collection at the NTC by identifying a complete list of required inputs.

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